

FUNK & WAGNALLS

WILDLIFE ENCYCLOPEDIA

7





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VOLUME 7

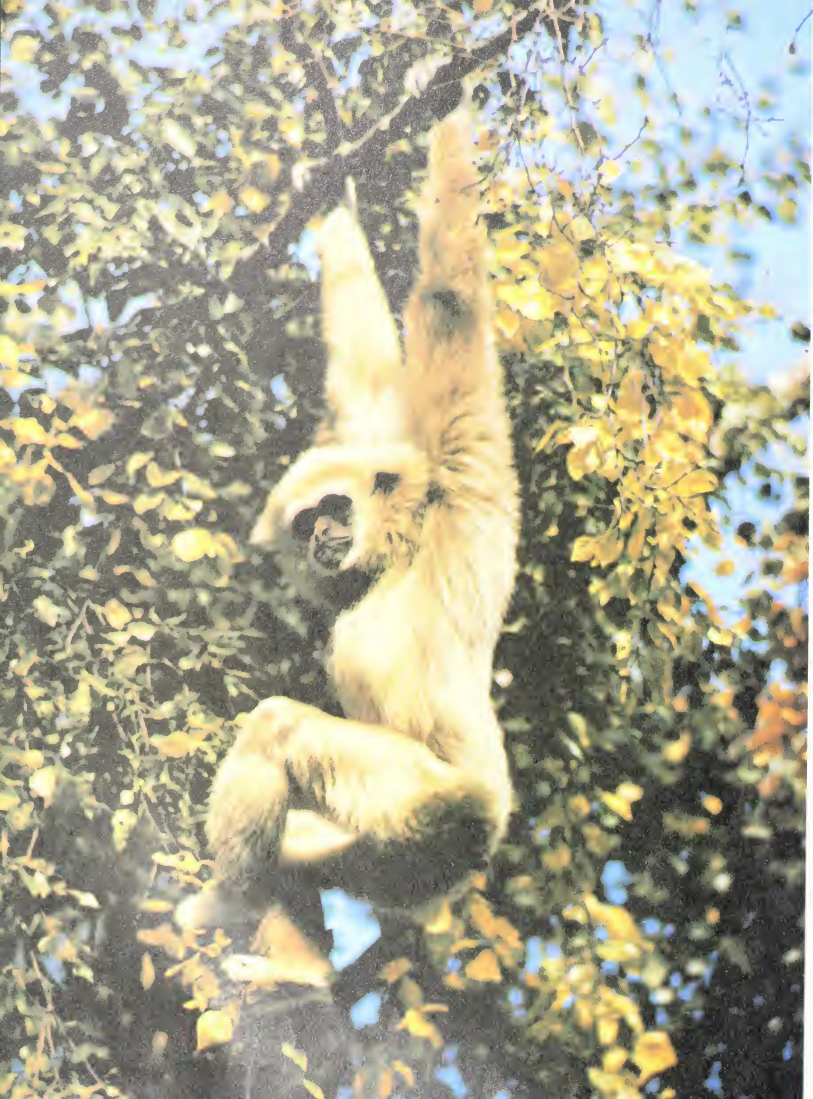
FRONTISPIECE |
Gibbon. (Page 850)

Its teeth, ears, and shoulders are adapted for swinging hand-over-hand and leaping from branches in the forest. This movement is known as brachiation.

COVER PHOTOGRAPH

Gazelle. (Page 827)

They usually live in dry country, although some live on fertile plains. Male gazelles have sweeping lyre-shaped horns, but the females have short spikes or no horns at all.



**FUNK & WAGNALLS WILDLIFE
ENCYCLOPEDIA**

GENERAL EDITORS • Dr. Maurice Burton and Robert Burton

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Fish eagle

The African fish eagle has been described as the most handsome of African eagles with its black flight feathers and white head, back and chest contrasting with the chestnut of the remainder of the body. It is found all over Africa south of the Sahara. It is also known as the African sea eagle or river eagle, but L.H. Brown, the authority on African eagles, has maintained that fish eagle is the best name. Compared with a bald eagle (p 128) or a golden eagle, a fish eagle is small, having the same body length as a herring gull. The fish eagle is found on rivers, lakes, along the sea shore and sometimes on quite small patches of water such as ponds or small swamps.

In Madagascar the fish eagle is replaced by the closely related Madagascar fish eagle, while there are two fish eagles in the Indian and Malayan regions that belong to another genus.

Diving for fish—and birds

The fish eagle has been called the 'voice of Africa' because its musical welping call is so often heard. It is usually seen in pairs, searching for food in a home range they occupy all the breeding season, and often throughout the rest of the year. A home range is not the same as the territory of a songbird, for instance. It is not defended and the ranges of neighbouring pairs can overlap slightly.

Within the range a pair of fish eagles have several favourite perches on the boughs of trees where they can look out over the water for prey. Here they spend a considerable part of their time, perching motionless then launching off on short sorties. At other times they hunt from the air, soaring in circles over lake or river.

The usual food of fish eagles is fish but they also prey on other birds and when living near riverside or lakeside villages they become scavengers, feeding on floating offal and refuse. Fish, such as tilapia and catfish, are caught as they swim near the surface. The occasional lungfish is caught as it swims up to the surface from the bottom to gulp air. Two methods are used to catch fish. Small fish are caught by a rapid dive from the perch or from the air, the eagle plunging in to grab the fish in its talons. Larger fish are caught by slowly flying to a position just over them then plunging the last few feet. The eagles have difficulty carrying large fish so they carry them back by flying low and dragging them across the surface of the water then climbing just before reaching the perch.

Fish eagles also raid the colonies of water birds such as little shags and darters, and some fish eagles may subsist mainly on young birds during the latter part of the breeding season, if there is a colony nearby. We have seen how young darters leave the nests and take to the water if molested (p 613). This is a sufficient defence against some predators but not against fish eagles which can catch the young darters while they are swimming. Adult darters and shags



△ Like a heraldic crest: a fish eagle straddles aggressively in the shallows beside its latest kill.
▽ Still glaring suspiciously from side to side with wings hunched, the eagle drags fish ashore. As fish eagles have trouble in carrying large fish in flight, they prefer to lug them onto dry land.



▽ Caution abandoned: the eagle tears greedily at the fish as it makes its meal



are also caught as they swim underwater and fish eagles will also take larger birds, such as herons, egrets, and flamingos.

Stealing other birds' nests

Each pair of fish eagles build one or two nests in tall trees. The nests are built 4m x 1m across, made of sticks and paper, and 5 m across, made of sticks and paper, sedge and lined with the matted grass mats of weaver birds, which are torn away from their foundations on the branches of trees and carried to the eagles' nest. It is not unusual for small birds to nest near the nests of birds of prey or of aggressive birds such as woodhoopoes (p. 670). In this way they are protected from enemies which are kept away by their larger neighbours. While birds of prey see how the nest they have made for their small birds can even nest in the foundations of their protective nest with complete impunity unless it is a fish eagle's nest. Weaver birds sometimes nest under fish eagles' nests, and although safe themselves, their trust in the eagles is violated by the eagles stealing the nests for use as homes.

At the start of the breeding season neighbouring pairs of fish eagles call to each other. This apparently helps to stimulate them into breeding condition. A pair may also be seen courting, perching or soaring together and sometimes grappling with their talons and falling hundreds of feet locked together before separating.

Two eggs (rarely 3) are incubated by the female for about 6 weeks. When the chicks hatch they are covered with white down and are very feeble. The female broods them continually at first. When they are 2 weeks old the first feathers sprout. After 65 days they leave the nest and walk out along the branches, where they perch and exercise their wings. They are able to fly when 10 weeks old.

Surprising ancestry

We generally think of birds of prey as feeding on mammals and birds. We imagine them pouncing on mice, rabbits, sheep or deer, depending on the size of the bird. Fish do not seem to be a likely diet for what appear to be very much land birds. Yet many birds of prey live mainly on fish. There are the fish-eating eagles, the sea eagles, including the bald eagle and the osprey.

In considering a habit or a structure of an animal, biologists are interested in whether it is primitive or a recent specialisation. The fish-eating habit of these hawks could be a recent development to take advantage of an alternative supply of food, or they could be the last species to practise what was an ancient and widespread habit among their relatives. Glover Allen, an American ornithologist, has suggested that the latter alternative is correct, as the hawks appear to be related to herons, definitely a fish-eating family. The evolution of the habit is difficult to trace as it only leaves a mark in the fossil record if it is associated with some special adaptation in the bones. There is no such adaptation in fish eating in the bones of hawks and, because very few fossils have been found, the relationships between the families of birds is often more conjecture.



P. Johnson



J.S. Wightman

class — Aves
order — Falconiformes
family — Accipitridae
genus —
& species — *Haliaeetus vocifer*

Top: A soaring fish eagle on the look-out for the next meal. Apart from quartering local stretches of water in wide soaring circles, fish eagles often select favourite perches (below) from which they scan the terrain before taking off on hunting sorties.



A little of what you fancy: rare picture of fishing bats *Pisonyx vivax* feeding.

Fish-eating bat

Bats are mammals and the only ones in this class to fly and not just glide. They form the second largest order of mammals—only the rodents have more species.

Compared with other bats, the fish-eating bat is not particularly ugly although its alternative name is bulldog bat. Its upper lip is divided into a harelip and there are folds of skin under the lower lip so there is a superficial resemblance to the muzzle of a bulldog. The nostrils project a little beyond the lips giving the bat a rather quaint appearance, but it lacks the complex folds of skin above the nose, the nose-leaves as they are called, of the more repellent bats.

Fish-eating bats have long, narrow wings with a 20 in. span, stretched—as is usual in bats—between the greatly elongated 3rd, 4th and 5th fingers of the hand and running to the ankles. Between the hind legs is the interfemoral or tail membrane. The tail runs down the centre of the membrane. In the fish-eating bat it only reaches halfway. The skin is naked except for short reddish-brown fur around the head and shoulders and down the middle of the back.

The fish-eating or bulldog bat is one of three species of bats, belonging to separate families, that prey habitually on fish. The other two are the fishing bat *Pisonyx vivax* of Baja, California and Sonora, Mexico, and the false vampire bat

Megaderma cor of India and southeast Asia which also feeds on insects, birds, frogs and other bats. The fish-eating or bulldog bat lives in America from northwest Mexico southwards to northern Argentina and on the Antilles and Trinidad.

Impaling fish with their claws

During the day fish-eating bats roost in clefts in rocks or in hollow trees. These roosts can easily be found by their powerful and unpleasant smell, which can be de-

tected from 100 yd away. At dusk, or sometimes during the day, the bats come out to feed on fish which they catch from both fresh and sea water.

The feeding habits of these bats have posed a series of problems. First came the question of what they fed on, and this was quite easily settled. A zoologist on an expedition to the Caribbean, organized by the US Fish Commission in 1883, saw some fish-eating bats in broad daylight, flying low over the waves in the company of some pelicans that were fishing. The bats also appeared to be fishing as they occasionally dipped down to touch the water. Later some bats were shot as they flew out of a cleft in the cliff face, and their stomachs were found to contain nothing but fish. This is not their exclusive diet, however. They also catch aquatic crustaceans as well as crickets, flying ants and beetles.

The next problem was how the fish were caught. At one time it was claimed that the tail membrane was used as a fishing net, but high-speed photography showed that the bats were using their long, sharp claws, like those of the Mexican fishing bat, as a gaff. They dip their feet in the water trailing them for anything up to 3 ft, and impaling fish about 1–3 in. long and sometimes up to 1 in. They then lift the fish quickly to their mouths and either eat them in flight or store them in cheek pouches until they return to their roosts. Captive bats caught 30 to 40 fish in one night from an artificial pool, but they would presumably catch considerably less than this in the wild.

The only observations on breeding are of female fish-eating bats carrying single babies from January to April.

Hunting by 'radar'

Until Donald Griffin, the distinguished American zoologist, showed that bats used echo-location to navigate in the dark, sending out ultrasonic pulses and listening for the returning echoes, it was thought that fish-eating bats merely trailed their claws in the water at random, on the off-chance of catching a fish. Even if they struck a shoal, it is difficult to believe that this method



Fish-eating bat *Noctilio leporinus*

The range of *Noctilio leporinus*.

would be very successful. The demonstration that bats used echo-location to detect their prey seemed to show how fish-eating bats could locate fish and spear them accurately. There was one great drawback. The ultrasonic squeaks would be almost entirely reflected back off the surface of the water. Only 0.1% of the sound energy would penetrate the water. Similarly, any sound that might reach the fish and be bounced back would itself suffer a 99.9% loss as it went back into the air. Furthermore, the sound waves would only be reflected by a fish if it had an air-filled swimbladder because flesh offers about the same resistance to sound as does water, so there would be no noticeable echo from it.

Despite these problems it was still argued that a bat might be able to detect fish underwater by flying slowly and very low over the water, as fish-eating bats do, and directing their echo-locating pulses vertically downwards by means of their protruding nostrils.

The problem seems to have been solved by some experiments carried out with tame bats that learnt to catch fish from shallow tanks. They were unable to detect fish or balloons, representing swimbladders, that were just underneath the surface, but they would dip down at any ripples or upwellings. More careful tests showed that they could detect a wire of 0.2 mm diameter sticking $\frac{1}{2}$ in out of the water from a distance of about 2 ft and a $\frac{1}{2}$ in. cube of fish flesh from 5 ft. So it seems that the bats can only catch fish that bob up to break surface either to catch an insect or for some other purpose. This would explain why the bats are seen fishing with pelicans. The birds are making the fish flee in panic and break surface in doing so. They have also been seen hawking over shoals that are being looted to the surface by predatory fish underneath.

class	Mammalia
order	Chiroptera
family	Noctilionidae
genus	
& species	<i>Noctilio leporinus</i>

(An excellent account of flamingo behavior
by greater flamingos like to see it)



Flamingo

Beautiful but bizarre, flamingos, like giraffes, have an appearance of unreality bordering on disbelief. Their necks and legs are proportionately longer than in any other bird; they feed with their heads water yet keep their delicately pink plumage immaculate.

There are four species of flamingo in both Old and New Worlds. Their plumage is tinged with pink, except for the black flight feathers. The greater flamingo, standing about 4 ft high, is found in America from the Bahamas to Tierra del Fuego, including the Galapagos Islands, and in the Old World from southern Europe to South Africa across to India. The lesser flamingo lives in eastern Africa and India. The two remaining species live in the Andes, 14 000 ft above sea level, in Bolivia, Chile, and Argentina. The Andean flamingo is common locally, but the James' flamingo is very rare and at one time was feared to be extinct.

Vast flocks of beautiful waders

Flamingos are gregarious, living in vast flocks of many thousands. One colony of the lesser flamingo in East Africa, the commonest species, numbers at least 1 million pairs. Flamingos breed, feed and travel in flocks and a flock of flamingos wading or swimming in a lake or flying in skeins, like geese, with necks and legs outstretched and wings slowly beating must be amongst the most beautiful sights in the world.

Flamingos are always found on lakes or lagoons of brackish water, where they breed and feed in shallow water. Many of them are migratory, and in recent years greater flamingos from the Camargue have been found to be flying south across the Mediterranean to spend the winter in Africa on the same lakes as the lesser flamingos.

Upside-down filter feeding

Shallow lakes and lagoons are the invariable homes of flamingos because it is here that minute plants and animals exist in the vast concentrations needed to feed the flamingo flocks. Flamingos extract their food from the water by a filtering mechanism very much like that used by the blue whale (p 248). They wade through the water with necks lowered and heads upside down, sweeping from side to side. They adopt this unlikely position to sieve their food from the water. The upper and lower mandibles of the bill are fringed with bristles which trap particles as the flamingo sucks in water. The outer layer of coarse bristles keep out large particles while minute algae such as diatoms are collected on an array of bristles inside the bill. The collected algae are then worked off onto the tongue and swallowed after the water has been expelled.

The greater flamingo has a more varied diet than other species. The other flamingos sweep their heads through the surface water but the greater flamingo feeds nearer the bottom. Its bill has fewer filtering bristles



△ Anxious parent vintres down to inspect its egg. △ Flamingo chick demonstrates how to sit down
▽ A stilt-legged trio of greater flamingos, showing off their balance on dry land







Leonard Lee Rue III

Bob Campbell Photo Res

◁ A living white and pink-washed carpet of lesser and greater flamingos, which feed side by side in vast mixed flocks on African lakes.



△ Aftermath of disaster: smashed and deserted eggs in the potash-ridden waters of Lake Magadi.
 ▽ White pelicans and flamingos at dawn.

Andrew Anderson NHPA





A flock of lesser flamingos feeding with their characteristic shrimping-net action, sifting the water with backward movements of the inverted bill.

A. Christensen

and has a flatter upper mandible. With it the greater flamingo sweeps up small snails and shrimps, as well as quantities of mud from which it extracts the organic matter, rejecting the inedible silt. The greater and lesser flamingos feed together in mixed flocks in the lakes of eastern Africa as the slight difference in feeding ground and feeding habits is sufficient to prevent them from competing for food.

They nest on hummocks

Flamingos breed in colonies. In East Africa where they are most abundant the colonies may be enormous. Several with over 900,000 pairs are known and at one time it was estimated that one had over 1 million pairs. Sometimes a particular colony may be deserted for several years in succession. Then the flamingos may perhaps rear two broods in very quick succession.

The erratic nature of the breeding is most likely due to changes in the water level of the breeding lake. The nests are towers of mud some 6–14 in. high with a depression in the top for the eggs. The water level has only to rise a foot or so for the colony to be inundated. On the other hand, if the water level of an alkaline lake drops, thick crusts may form and become caked on the legs of flamingo chicks when they leave their nests. In 1962 Lake Natron in Kenya was flooded and the flamingos moved to Lake Magadi to breed. Thousands of chicks perished, caked with soda that formed heavy anklets round

their legs. A rescue operation was launched and many chicks were saved. A flamingo is long lived, however, and produces many chicks in its lifetime, so it is very unlikely that such a catastrophe would have a serious long term effect on the population.

At the beginning of the breeding season the flamingos indulge in spectacular courtship displays. Banding together in tightly-bunched flocks the male flamingos run to and fro with the necks held straight up and bills pointed skyward. At the same time there is a continual guttural uproar while the flock appears to be shimmering because the flamingos are jerking their heads sideways, buttally and never in unison. At other times they bend their necks, sweeping them bills across their backs. Within the colony of thousands of flamingos these tightly knit flocks of males flow and ebb, their long legs twinking as they rush to and fro.

A single egg is laid in the saucer-shaped depression in the nest and is incubated for a month by both parents in turn. After the chicks hatch they stay on the nest for 2–3 days then they join the other chicks in bands which can run readily and swim when 10 days old. The chicks look very much like goslings. They are covered in grey down and their bills are straight, not sickle-shaped like their parents. Because of the resemblance of young flamingos to goslings and their 200–250-like flight of the adults, flamingos have been thought to be related to geese. But most ornithologists now think that the

flamingos are related to storks and ibises.

Until its bill has developed the characteristic shape, a young flamingo is unable to feed itself and has to rely on its parents. To feed a chick a parent stands behind it and lowers its neck so the chick may take the tip of its bill in its own. The adult regurgitates liquefied food which runs down into the chick's mouth. The parents seem to be able to recognise their own chicks even when they are among a dense crowd of other chicks which may be running or swimming together. The crowds of chicks are always accompanied by adults that lead them away from danger.

Many enemies

The main enemies of flamingos are the fish eagles that can pick the young flamingos out of the rafts and carry them off. Hyenas, cheetahs and jackals also kill any stragglers they find. In Roman times flamingo tongues were a delicacy and flamingos are still eaten by local hunters. At one time they were prized for their plumage but now the main human menace to them is disturbance of the breeding colonies, especially by low flying aircraft.

How do they sit down?

While idly looking at the more grotesque animals at the zoo, one is often led to wonder how they carry out simple everyday functions. How, for instance, does a heron

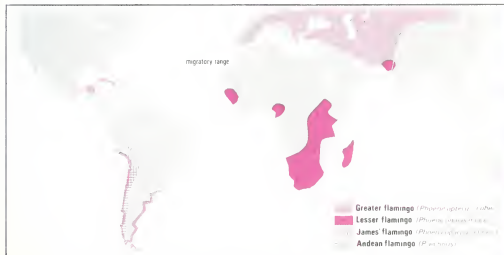


Mass-produced beauty: dense flocks of flamingos throng an African lakeside in company with grey-headed gulls.

or a flamingo sit down on its nest? Strangely, this was long in dispute, perhaps because the ornithologists writing about flamingos had never seen them at their nests and could only theorise. In 1697 William Dampier thought that the flamingo leaned back on its nest as if sitting on a shooting-stick. Even a century ago there were still some strange ideas on this point. One was that it sat astride its nest, another that it sat with the legs sticking straight out behind. The correct answer is that it sits like any other bird. The legs are doubled up beneath it, the 'knees' (actually the ankles) hinge backwards, so the folded legs stick out behind the sitting bird.

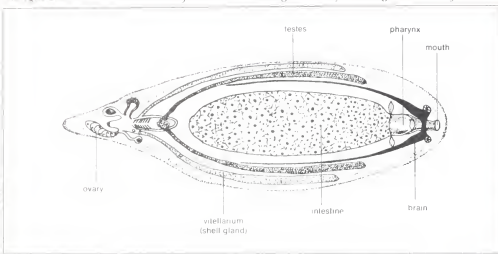
class	Aves
order	Ciconiiformes
family	Phoenicopteridae
genera & species	<i>Phoenicopterus ruber</i> greater flamingo <i>Phoeniconaias minor</i> lesser flamingo <i>Phoenicoparrus jamesi</i> James' flamingo <i>P. andinus</i> Andean flamingo

▷ *Rarity in captivity: the James' flamingo, which lives in the Andes, 14 000 ft above sea level. Very scarce, it was once believed extinct.*





△ Not a blood thirsty banana but a freshwater flatworm rejoicing in the name of *Dabellia*. enlarged 110x = natural size. These flatworms normally get about by crawling on a track of slime.



△ Diagram of the 'working parts' of a similar flatworm (after van Graff). The nervous system is simple and very primitive; a flatworm does not die if it loses its brain in an injury.



Flatworm

Free-living flatworms are of great interest to scientists because of the light they shed on animal behaviour at a low level. There are three classes of flatworms: a variety of free-living forms and also the parasitic flukes and the tapeworms. The last two will be described later. Only the free-living *Turbellaria* will be considered here. They are soft-bodied, unsegmented and generally flattened worms. The planarians of our rivers and ponds are the best known. They range in size from microscopic to, exceptionally, well over a foot long in the case of certain terrestrial species in humid tropical forests.

Living without a brain

Planarians live mainly in fresh or salt water. Those living on land are restricted to moist places and are mainly tropical, although there is one, *Rhyacionemus terrestris*, like a small slug, 4 in. long, sometimes as much as 1 in., dark slate grey, found under the bark of decaying trees in Britain. *Turbellarians* usually move about in two ways. Most of the time they crawl on a

track of slime laid down by their under-surface, movement being due to cilia beating against the track. At other times they move more rapidly, by means of muscular contractions. Certain freshwater species move about over the surfaces of such animals as crustaceans and snails by alternately attaching themselves by a sucker at the hind end and by tentacles at the other.

The nervous system is primitive and extremely simple, and ill-defined. There is a simple 'brain' at the front end where the eyes, if any, and other sense organs are located. The brain is in some respects relatively unimportant. For example, the animal can feed almost normally even when the brain has been lost by injury. Nevertheless, turbellarians do show well-defined reactions to light, gravity, water currents and chemical stimuli, and these reactions have interested biologists because of the lowly state of the nervous system which produces them. Moreover, flatworms also show an ability to learn; for example, to turn right or left in particular laboratory situations. They have attracted special attention because of experiments carried out in the hope of showing that 'memory' can be transferred from one animal to another in chemical form. As we shall see later, a flatworm can be cut into several pieces and each

will reform to make a new, very small flatworm. In an experiment a flatworm was 'trained'. Then it was cut up, the separate pieces regenerated and each new flatworm was tested to see if it 'remembered' the training. The scientists carrying out the experiment claimed that each new flatworm remembered. Were this so it would mean that memory, contrary to what we normally suppose, could have a chemical basis independent of the nervous system. There is, however, some doubt about the validity of these experiments.

Secondhand defence

The digestive system has only one opening, the mouth, and the form of the mouth serves to distinguish the four different kinds of flatworms. In the *Rhabdocoelida* the intestine is straight and the mouth is at the front of the body. In the *Tricladida*, or planarians, the mouth with a protrusible proboscis is near the centre of the body and the digestive system has three main branches, each of which branches extensively through the body. In the marine *Polyclads*, there are many branches of the gut leading from a mouth at the posterior end of the animal and in the *Acoela* there is a simple gut that is not even hollow. This last is less mystifying than it appears when we realise



△ Four specimens of *Dendrocoelum lacteum*, found crawling on the underside of a piece of floating wood. Notice the muscular body contractions, which help them to move more rapidly.

that digestion in all these animals is largely carried on, not inside the intestine but in the cells of the wall of the gut.

The turbellarians are carnivorous, feeding on a variety of small animals. Some of them can be caught by lowering a piece of meat on a string into a pond. The typical planarian catches its prey with the help of sticky secretions from glands in the head region. When the prey gets caught in these the planarian wraps its body around it. The proboscis is then protruded from the mouth and small particles of the prey are sucked up. One of the Rhabdocoelida *Microstomum* has the remarkable habit of feeding on hydra, a freshwater relative of anemones. It eats portions of the hydra, including its stinging-cells and these find their way into the skin of the *Microstomum* and are used in defence by their new owner. In fact, *Microstomum* is believed to eat only hydra when it needs to replenish its armoury.

On the sandy shores of Normandy and Brittany live two species of flatworm Acoela that may be so abundant as to colour the sand green. The colour is due not to the worm itself but to single-celled algae living in its tissues. One of them, *Convoluta roscoffensis*, gets all its food from these plant cells once it is mature, but the other, *C. paradoxa*, like the young of *C. roscoffensis*,

takes in solid food as well.

Cannibalism is common in Turbellaria. Even *Convoluta* when kept in the dark will eat their fellows. By contrast not many other things eat them.

If starved, flatworms get smaller and smaller, their internal organs disappearing in an orderly sequence, the reproductive organs first and the nervous system last.

Generation ...

The reproductive organs of Turbellaria are most complicated. Each individual has elaborate sets of both male and female organs. Propagation is, however, not always sexual. A number of freshwater planarians reproduce by tearing themselves in half, the front end of the body advancing while the rear attaches itself firmly to the substratum by sticky secretions. The body gives way along a predetermined line of weakness. The two halves subsequently reconstitute themselves as whole worms. The common American *Dugesia tigrina* does this, and in some localities there is, apparently, no sexual reproduction at all. In some rhabdocoels a chain of individuals is formed, each with its own brain and other organs, and after that they separate. Other turbellarians propagate by fragmentation. An interesting example is



△ Land planarian on a Malayan forest floor. These tropical land-living species grow large.

provided by the large *Bipalium kewense*, discovered in 1878 in the greenhouses of Kew Gardens and now occasionally turning up in others elsewhere. It is also established in gardens in the West Indies and the warmer parts of North America although its relatives are mainly native to the forests of southeast Asia. It sometimes reaches 1 ft long and has five dark stripes on a lighter background. This species cannot reproduce sexually in temperate regions so for its survival there it depends on multiplication by fragmentation.

and regeneration

Turbellarians have also very good powers of regeneration following injury. Indeed, they have been favourite animals for studies on this subject and zoology textbooks often contain pictures of monstrous flatworms with several heads or with a head at each end. In some species, new individuals may be regenerated from as little as a thousandth part of the whole.

phylum	Platyhelminthes
class	Turbellaria

Flea

Fleas are small, wingless insects, parasites with the body flattened from side to side, making it easy for them to slip through the fur or feathers of the host. The legs are modified for rapid movement in the environment and also for powerful jumping, and the thick, leathery skin is a good defence against the host's scratching.

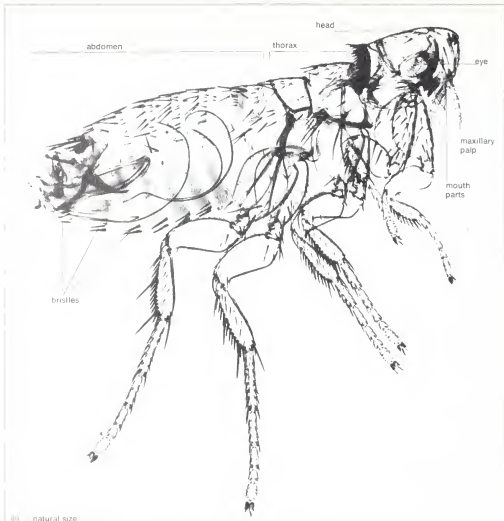
The genus *Flea* is used for any member of the order Siphonaptera, of which a little over a thousand species are known, but over 50 and 60 having been found in Britain. The order is very distinct and isolated from other insects, but there are indications of convergent evolution and a relationship with the *Siphonaptera* (Microptera). All these live, when adult, as blood-sucking parasites of mammals or birds. They become live on the bodies and live that accumulate in the fur or hair of the animals which are the hosts of the parasite's insects.

The eggs are large for the size of the insect, about 0.5 mm long, and white. The larvae are small, whitish, maggot-like, legless but having a pair of short antennae and biting jaws. The pupae grow in cocoons.

In 6 flea species the female is sedentary, remaining attached and feeding in one spot. She may even burrow into the skin of the host. The tropical jumping flea *Tunga penetrans* being an example of this.

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△ Flea specimen shows the tough, bristle-covered shell—a good defence against scratching hosts.
 ▽ Prepared specimen displays powerful legs.

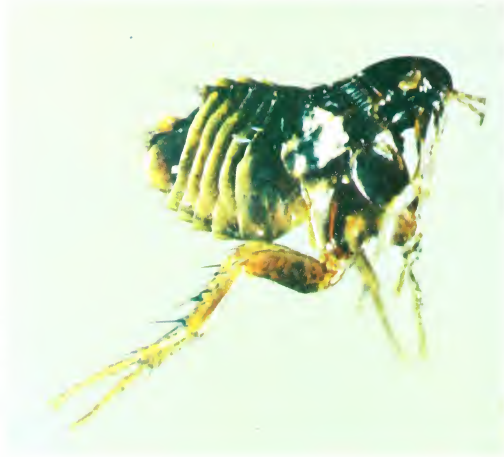
▷ Making the most of babyhood: a flea gorges itself on the blood of a blind, defenceless common shrew infant.

Choice of targets

Fleas usually parasitise only mammals and birds which have a lot of nest in which they live and breed, or which congregate in large numbers in regular roosts. The majority of known species are parasites of rodents, most of which live in nests or burrows, and insectivores and bats are also much infested. Apart from man, primates are never more than casually infested. Monkeys do not as a rule carry fleas at all. Aquatic mammals such as otters and coypus are also not attacked by fleas and among the hooded animals, the pig is one of the few animals regularly infested.

Among birds fleas are most common on the species which nest in holes or in wood-pockets, pits and the sand between the feet being perhaps the most flea-infested of all birds. The rock dove and its descendants and the domestic pigeon have a special flea of their own *Ceratophyllus columbae* and they are found on wood pigeons. Possibly in these are rock doves and domestic pigeons nest in holes and on ledges while wood pigeons make an openwork nest in trees. This underlines the basic requirement for infestation by fleas, which is a suitable environment in the host's nest for the non-parasitic developing larvae.

It is unusual for fleas to be confined to one host. Both the flea of the rock dove and the sand martin's flea *Ceratophyllus* are restricted to the one species. Most fleas will feed and breed on a variety of hosts; the



human flea *Pulex irritans* is found also on pigs, and the hen flea *Ceratophyllus gallinae* feeds on a great number of different birds and can live on mammalian, including human, blood as well.

Carriers of disease

Fleas will also casually infest hosts with which they have no breeding association. Cat fleas, finding themselves on a human, bite readily. The incidence of the dreaded bubonic plague is mainly due to a particular flea *Xenopsylla cheopis* that normally lives on rats, leaving these bodies when they die of plague and infesting people whose hygienic standards permit rats to live in numbers in their dwellings. The bacterium *Yersinia pestis* that causes plague affects rats and men equally severely and is conveyed from one to the other in the saliva of the fleas. In mediæval times practically no house was free of rats and the great epidemics of plague or 'black death' killed millions of people.

In the jigger flea, the female burrows into the skin of its human host. Both sexes start their adult life as very small fleas, hopping about in the dust around human habitations. After mating the females burrow into the skin of people's feet under the toenails and grow to the size of a pea, forming a cyst. This causes a great deal of pain and is difficult to remove without causing sores or abscesses due to secondary infection. The hen stick-tight flea *Echidnophaga gallinacea* infests poultry and the females gather on the naked skin of the birds' heads and attach themselves permanently. This flea's choice of hosts is quite unusual; it infests poultry and various small mammals, clustering on their ears, and is particularly partial to hedgehogs.

Fleas in storage

The eggs of fleas are dropped into the nest of the host or may be laid among its fur or feathers, whence they are shaken out and many fall into the nest. Almost all fleas require a meal of blood before they can develop and lay their eggs. The tiny maggot-like larvae feed on dirt and debris, including dried blood, in the host's nest, or in dusty unswept corners in human habitations. When fully grown they make cocoons and pupate. The pupae often lie dormant for long periods and in some species, including the human flea, are sensitive to movement and vibration, which stimulates them to hatch. Campers, invading a deserted house that has been abandoned months before, may be greeted by hordes of fleas that hatch in response to the tramping and dumping of heavy luggage. This is an obvious adaptation to delay hatching of the pupae until a new host and source of blood appears on which newly-emerged adults can feed.

Greedy blood-suckers

Like other blood-sucking insects fleas have special sucking mouth parts. The most important part is a narrow tube formed from three needle-like stylets, an anterior and two lateral ones. They are serrated towards the tip to increase their efficiency in piercing. An anticoagulant 'saliva' is injected before the blood sucking commences. It is this which causes the irritation associated with a flea bite, and which leads to disease





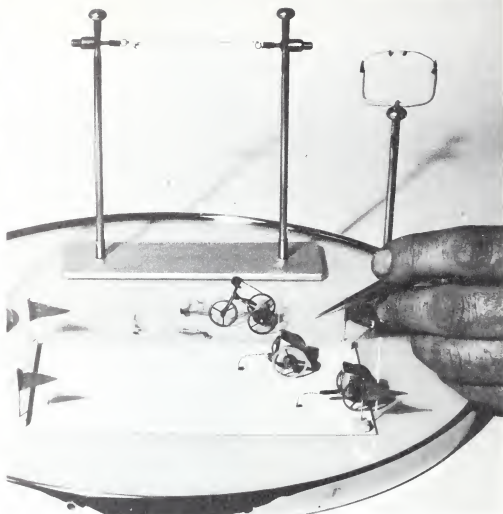
△ Flea sword-fight and chariot race.

organisms being passed into the blood of the host by infected fleas.

Fleas are very greedy feeders and only digest and assimilate a fraction of the blood they suck up, the rest being passed out of the intestine unchanged. It is thought that this apparently wasteful habit may have been evolved to provide a supply of dry coagulated blood for the flea larvae which are feeding in the nest of the host. If this were so it would be an example of a parent insect making provision for its larvae resembling, but far less elaborate than, that used by wasps and bees. The idea may not be as far-fetched as it appears. The larvae feed in the normal way, searching for edible particles among their surroundings and chewing them in their mandibles.

When parasite eats parasite

Fleas are regularly caught and eaten in small numbers by their hosts, usually in the course of licking, cleaning and preening. This benefits another form of parasite. The common tapeworm of dogs and cats *Dipylidium caninum* spends one phase of its life cycle in dog fleas and depends on the fleas being eaten to get from one host to another. Far more effective enemies of fleas are certain mites which live in nests and prey on the fleas in all their stages. Small beetles of the genus *Gnathocoris* are often found in birds' nests, and they also prey on fleas and their larvae.



△ The gadgets of a flea circus 'ring': chariots, a tricycle, a tight-rope, and sword-fighting frame.

Performing flea

At one time the flea circus was a familiar item of entertainment in country fairs. *Pulex irritans* was still an abundant and familiar insect 50 to 100 years ago when the forms of public entertainment were far less numerous and less sophisticated than they are now. At the present time the manager of a flea circus would be faced with two difficulties. He would probably have difficulty in finding an audience and he would certainly have difficulty in finding a sufficient supply of human fleas for his performers. He would therefore have to be content with dog or cat fleas, which are not easy to feed in captivity.

It was customary for the proprietor of one of these circuses to keep human fleas and feed them on his own arm. A large part of his skill lay in constructing tiny devices such as tricycles and 'chariots' which could be propelled by fleas attached to them in such a way that the crawling of the insect caused them to move. Another very delicate operation was the tethering or harnessing of the fleas with very fine gold or silver wire. There was never any question of the fleas being taught or trained in any way, though of course this was always claimed as part of his expertise by their owner. Advantage was simply taken of the natural movements of the insect when restrained in various ways. The real skill displayed by those who ran

flea circuses lay in making the 'props'. One was a coach, of tiny proportions, perfect in every detail which was drawn by a team of fleas.

The relatively enormous size and rapidity of the flea's jump has puzzled naturalists since the time of Socrates. It has recently been shown that in addition to the powerful leg muscles and tendons, the flea's jumping apparatus incorporates a cap of resilin, a rubber-like protein which, when compressed and suddenly released, delivers power faster than most actively contracting muscle. Resilin is generally a component of the wing-hinge ligament of flying insects, such as dragonflies and locusts, and its presence in the thorax of fleas suggests that they have adapted and modified a flight mechanism to increase their mobility while living among fur and feathers. In other words fleas are insects which fly with their legs.

Adult fleas are remarkably long-lived. Supplied regularly with blood a human flea has survived 513 days, and a Russian bird flea is said to have lived for 1487 days or a little over four years.

class	Insecta
order	Siphonaptera
genera	<i>Pulex</i> , <i>Tunga</i> , <i>Echinophaga</i> others

Flicker

Well known and admired for their beautiful plumage and wide variety of calls, flickers are a group of small American woodpeckers. The six species are found from Alaska to southern Chile. The yellow-shafted flicker of North America, which has 132 local names, is grey brown with black bars on the wings and tail and black spots on the underparts. There is a black band across the breast and a red nape. The name comes from the yellow shafts of the tail and wings that impart a golden glow to the plumage. During its rapid undulating flight its white rump can be seen. In the west of the United States the yellow-shafted flicker is replaced by the red-shafted flicker. It is similar in habits and appearance except that the feather shafts are red. It is very likely that the two are different forms of the same species.

Popular drummer

The striking plumage of flickers makes them popular, although they may occasionally lose their popularity when they drill holes in wooden buildings. They live in open country or sparse woodland and also ham farms, orchards and gardens in towns. In the northern United States most of the flickers migrate south for the winter, returning in early spring. At the first sign of mild weather the flickers begin to move north in flocks, mainly at night. Their passage is marked by the excited calling of the male flickers. From perches high in the trees they challenge their rivals with sharp calls of 'wick-wick-wick' repeated for half a minute or more. These calls can be heard for half a mile, but there is a softer call which is not so sharp.

Mopping up the ants

Most woodpeckers feed on ants that they dig out from under bark or from rotten timber, but some feed chiefly on the ground. Their main food is ants, which make up 15% of their diet. One flicker examined had 5,000 ants in its stomach. To find ants, flickers quarter the ground, scratching away leaves until the entrance to an ant nest is found. The entrance is torn open with a few well-directed pecks and, as the ants come swarming out, they are wiped up with a long sticky tongue. The eggs and pupae are also lapped up by inserting the tongue into the nest. In spring when the ants are less active, the flickers have to tear open ant hills to expose the torpid occupants.

Apart from ants, flickers eat a variety of other insects including beetles, wasps, grasshoppers, crickets and caterpillars. They catch flying insects on the wing. In another fashion (p 291) and sometimes a flicker will search for insects among twigs and leaves like a tit. Vegetable matter makes up 1% of the flicker's diet. Most of this consists of fruit and berries, including blackberries, elderberries, dogwood and poronyx. They also eat seeds of weeds, acorns and beechnut, and they take grains of oats and wheat from



Colourful fly-past - striking plumage makes the flicker a popular bird.

Howard Austin

stacks. In California avocados and oranges are sometimes attacked. The flicker is probably the only fruit-eating bird able to make a hole in the tough skins of oranges, but the damage they do is slight.

Action-packed courtship

Courtship takes place in early spring. It is a lively affair, full of action. The two birds dance around tree trunks boxing and nodding to each other and chasing each other from one tree to another. At other times the males call and advertise their presence by drumming on a trunk with their bills. The only difference in plumage between the sexes is the 'moustache' of black feathers worn by the male. This is important in recognising the sexes, for it was found that if moustaches were painted on females, they were treated as males and driven away by prospective mates.

After the pair has formed they set about searching for a nest hole, or if one is not available it is drilled out of a rotten tree. As they search they keep in contact by calling and drumming. If the male finds a hole, the female comes over to inspect it, for her choice is final. Once selected it is alerted to suit the flickers, being enlarged by chiselling with the bill. Sawdust is dumped outside but the larger chips are usually carried some distance from the hole.

Flicker nests can be found from ground level to 90 ft up. In open country they will

make their nests in telegraph poles or fence posts. Sometimes flickers will nest in houses, where they can drill their way into the roof and lay their eggs on the plaster between the rafters. Flickers will also nest on the ground, excavating their holes in banks. In treeless parts of South America ground-nesting is the rule.

White eggs, 5-11 in number, are laid on the bare floor of the hole. Both parents assist in excavating the hole, incubating the eggs and feeding the young. Incubation lasts about a fortnight and the chicks emerge naked and helpless. For 3 weeks they are fed on regurgitated food and then on food that is chewed first. After leaving the nest the young stay with their parents for 2 weeks, while the parents apparently teach them to hunt by placing food under crevices in bark in full sight of them.

Hawks take a toll

Squirrels, weasels, crows and other woodpeckers rob the nests of flickers and hawks take a toll of the adults. At one time man was their worst enemy. Flickers were considered game birds and were sold by game dealers. In the United States at least, this has ceased for flickers now enjoy legal protection.

At the turn of the century starlings were introduced to North America. They spread across the continent and have become a great nuisance to the flickers competing for

their food, especially in autumn when large flocks of starlings strip the berry crops. They also drive flickers from their nests, sometimes building a nest on top of the flickers' eggs.

Survival by numbers

The number of eggs in the clutches of different birds varies. Emperor penguins and albatrosses lay one egg whereas flickers may lay up to 14. Extensive studies have shown that the number of eggs a bird lays is very well adjusted to its life history. Birds that live for a long time, like albatrosses, lay few eggs; those that rarely survive more than a year or two lay many eggs to compensate for the high mortality. Furthermore, birds that lay large clutches can usually lay extra eggs if some are lost.

If an albatross or a gannet loses its egg through kicking it off the nest or because a predator eats it, it will lay no more that season. These birds are called determinate layers; the ovaries can produce only a set number of eggs each year. Other birds will lay more eggs if some are lost. The best known example of this is the domestic fowl, but an experiment showed that a yellow-shafted flicker was a very good layer. As each egg was laid it was removed from a flicker's nest and in 73 days the bird had laid 71 eggs.

The mechanism of laying extra eggs is not fully understood. It seems that the ovaries continue to form eggs until given a signal to stop. It is thought that the signal is the feel of the eggs against the brood patch that triggers the secretion of a hormone to act on the ovaries and inhibit further production of eggs. The advantage of this mechanism would be that it would enable the bird to replace any eggs that were lost or stolen or to begin a new clutch if the nest were destroyed.



class	Aves
order	Piciformes
family	Picidae
genus	<i>Colaptes auratus</i> yellow-shafted flicker
& species	<i>C. cafer</i> red-shafted flicker others

▷ Red-shafted flicker takes time out on a stump. Flickers are woodpeckers whose main food is ants, which make up 45% of the bird's total diet.



Flounder

The flounder is a flatfish of the shallow seas of western Europe, which may weigh up to 6 lb. Related to plaice, dab and turbot, the flounder is noteworthy because, although a marine fish, it is equally at home in saltwater or freshwater.

Its upper surface is greyish-olive, but may vary from yellow to almost black, and is marbled with brown. As a result it blends almost perfectly with the mud, sand or gravel on which it is resting; unless it moves it is hard to see. The pectoral and pelvic fins are small and the flattened body is ringed by the long

dorsal and anal fins. Like the dab (see p 600) the flounder comes to lie permanently on its left side. This underside is pearly white, which helps in identifying a flounder. Another difference from the dab is that the scales on its head, at the bases of the fins and along the lateral line, are thorny tubercles.

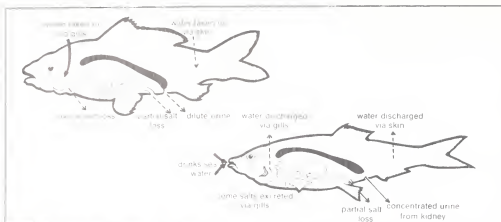
The name is of Scandinavian origin and has been applied to the common flounder *Platichthys flesus* since at least the early 15th century. Later its scope was extended to include closely related fishes of the western Atlantic and the North Pacific, as well as members of a closely related family *Bothidae* or left-eyed flounders.

Harmonizing with the background

As with other shallow-water flatfishes, flounders can change colour to match the background on which they are lying. Although they do not change the pattern of their colouring, only the intensity, this is enough to imitate the checkerboard pattern on which they have been placed experimentally. They make these colour changes not in response to light falling directly on the eye but the albedo, that is, the ratio of light reflected from the bottom or the background to that coming directly from a light source. That is why a flounder in an aqua-

▽ In a sand-coloured mood: a twist-eyed flounder peers down at the camera as it undulates on its way above the sea floor.





△ *Struggle with the salt problem.* Both saltwater and freshwater fishes have to preserve a fixed amount of body salt, but a freshwater fish (above) contains more salt than its surrounding water, while a saltwater fish is specialized for getting rid of body salt though surrounded by saltwater.
 ♀ *Spawning old habits in the old ways.* Crooked-mouthed face of a flounder.



rium with a blackened bed goes very dark, almost black. One placed in an aquarium with a sandy coloured bottom will go pale even when there is only a dim light falling on it from above. Also, a flounder in an aquarium with blackened sides and lit from below will show black spots on its mother-of-pearl midside.

Although the colour change is automatic, experiments have shown that a flounder will learn to change to suit its background more quickly with experience.

Teeth in its throat

The flounder's habits are much like those of the dab but it will more often enter brackish waters. It will also enter rivers, sometimes going well up into freshwater. Its food is linked with the type of teeth it has. As in the dab and plaice, the teeth are conical, well developed on the lower jaw but only feeble on the upper. Like the plaice, the flounder has crushing teeth in its throat

. These are conical with flattened tops; and are pinned to form a triangular crushing plate. The food of young flounders is small cockles and similar bivalve molluscs. Larger individuals, especially when in freshwater, take a more varied diet.

One set of gills is on the underside and the other is on the upper. Many fishes take a gulp of water into the mouth and drive it out from their gill-covers like a jet to make a spurt forwards. The flounder is said to squirt a jet through its underside gill to leap up from the bottom, like a hovercraft taking off.

Out to sea to spawn

Even a flounder that has gone well up a river into freshwater will, like those living inshore, go out to sea to spawn at some time during February–May. Marking experiments have shown they travel 3–4 miles a day on these spawning migrations to the well-defined spawning grounds. On the journey

they take no food but use the fat stored in the body to ripen the reproductive organs. By the time spawning is over a male will have lost $\frac{1}{2}$ of its weight and the female will have lost twice this.

The eggs are small, $\frac{1}{16}$ in. diameter, filled with yolk. Each female lays, on average, a million of them. They float to the surface, where they are fertilized by the males' milt that also rises to the surface. The period of spawning is later when the sea temperature is low, and the eggs then take 11 days to hatch. In a warmer season spawning is earlier and eggs need only 6 days to hatch. They can start developing when the water is below 0°C/32°F.

The larvae, shaped like those of any ordinary fish, live in the surface waters but gradually move inshore and sink to the bottom. At the same time their shape changes, as described for the dab (p 600).

Beset by enemies

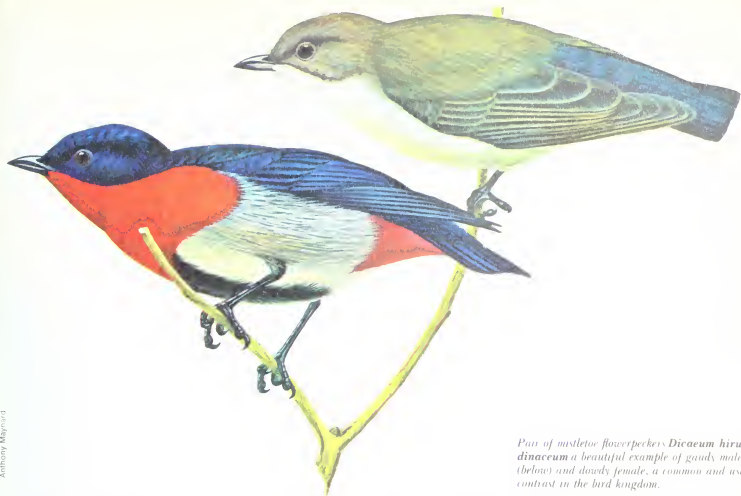
The eggs and larvae are eaten in large numbers by animals feeding on plankton, so only a very small percentage survive to maturity. Flounders are also afflicted by a single-celled animal parasite that causes white swellings in its skin. They also carry fish-lice (see p 770). Even without these the flounder is not rated high as a food-fish.

To drink like a (saltwater) fish

The popular saying "To drink like a fish" is only half true. At best it is ambiguous. Most fishes live either in the sea or in freshwater. The former must drink, the latter need not, and there is a good reason for this. The blood and tissues of a freshwater fish contain more salt than the surrounding water, so the fish tends to take in water, especially through its gills, and give out some salt all the time. So it should not become waterlogged, the fish must get rid of excess water and must control the loss of salt. Both these tasks are done by the kidneys. It is the reverse in the sea. There a fish tends to take in salt and lose water by osmosis through any permeable surface, such as the gills. So it must drink to offset the loss. In doing so it takes in more salt. So it must do something to get rid of excess salt. This is done partly by the kidneys, partly by special salt-secreting cells in the gills. One result is that its urine is concentrated and only small quantities of it are given out, whereas in a freshwater fish the opposite occurs.

Fishes like the flounder that can pass readily from fresh to saltwater and vice versa, must make rapid adjustments to meet these changed conditions. Going from salt to freshwater it stops drinking, increases the amount of urine it gives out and retains the salt in its body. On the return to saltwater it reverses these.

Class **Pisces**
 order **Pleuronectiformes**
 family **Pleuronectidae**
 genus & species ***Platichthys flesus***



Pair of mistletoe flowerpeckers *Dicaeum hirsutum* a beautiful example of gender male (below) and dusky female, a common and useful contrast in the bird kingdom.

Flowerpecker

Flowerpeckers are among the smallest birds in the Indian and Australian regions. There are 55 species, ranging from the size of a tit to that of a house sparrow. Their bills are sharp and their tails stubby. Typical flowerpeckers are found in India and eastern China across to the Philippines, down through Malaysia to Australia and Tasmania, where there is a second group called the diamond-birds or pardelotes.

Nectar drinkers

Flowerpeckers usually live high in the trees, from the bamboo groves and plantations of the plains and lowland rain forests to the moss forests of the hills and the scattered, stunted trees on the sides of mountains. The scarlet-backed flowerpeckers of Burma and Malaya are sometimes found in gardens. They are usually seen in pairs or small parties fluttering noisily through the trees in search of the flowers and berries of certain plants belonging to the family Loranthaceae. Flowerpeckers may congregate in larger parties if there is a good supply. The Loranthaceae are plants like mistletoe, parasitic on trees, sending growths into the wood of their hosts to extract sap, on which they live. Many flowerpeckers feed wholly on the nectar from the flowers of these plants or on their berries. The mistletoe-bird of Australia, the strongest living of all flowerpeckers, is nomadic, moving around the country in search of ripening mistletoe berries. Its breeding is timed to coincide

with the main mistletoe crop. Like several other flowerpeckers the mistletoe-bird also eats other berries and takes some insects and spiders.

The nectar-eating flowerpeckers have the same relationships with the flowers as insects. They eat the nectar and by going from one flower to another cross pollinate them. Several other tropical birds, such as honeyeaters, honeycreepers and sunbirds, also habitually visit flowers for their nectar and thereby pollinate them. They all have adaptations for this special way of life. Flowerpeckers have long tongues that curl over at the edges to form tubes, with which they suck up nectar from mistletoe flowers. While thrusting their heads into the flowers, the flowerpeckers brush against the stamens, which in mistletoe flowers are just inside the lip of the corolla. If the stamens are ripe, pollen is wiped onto the flowerpecker's head feathers. At another flower, this pollen is transferred to the stigma and the flower fertilized. The role flowerpeckers play in pollination is probably not as important as that of some of the other pollinating birds such as the sunbirds, but there is nevertheless a close relationship between the birds and plants. Without the birds the plants would not be fertilized.

Apart from the groups of birds already mentioned, hummingbirds and to a lesser extent bulbuls, orioles, shrikes and weavers also pollinate flowers. Both birds and plants seem to have evolved towards a common target. The flowers are brightly coloured. Red is the most important colour, followed by orange and yellow. The colour serves to attract the birds to the copious supply of nectar secreted and stored at the base of

the corolla tube. The nectar of bird flowers is much weaker than that of insect flowers, and insects are probably not attracted at all to bird flowers.

Nectar drinking in birds probably arose from an insect-eating habit. Habitual nectar drinkers have fine pointed bills reminiscent of insect eaters, and most of them still take some insects. They probably began visiting flowers in search of the very tiny insects that gathered there to collect nectar. Later the birds began to take nectar themselves. This stage has been reached by garden and willow warblers of Europe which are primarily insectivorous, but occasionally sip nectar. From here the transformation to habitual nectar drinking is not difficult to visualize.

Berry eaters

As well as pollinating the mistletoe's flowers, flowerpeckers disperse its seeds, and it is for this that the birds are best known. The Australian mistletoe-bird and many others do not carry out any pollination but can be classified as pests because they spread mistletoe so effectively. In temperate climates mistletoe is not very abundant, but tropical mistletoes run not over trees, completely smothering them and causing serious damage to mango and other plantations.

Flowerpeckers have two ways of eating mistletoe berries. Species with thin bills, such as Tickell's flowerpecker of India, swallow the berries whole, leaving just room for them to see if they are ripe. Bill marks can be seen on unripe berries where a flowerpecker has tasted and rejected them. After it has eaten 1 or 5 berries, the flowerpecker returns to a perch and shortly, perhaps



Left: The seedling of the parasitic plant, it is both rootless and green, feeding flowerpeckers.

in 4 or 7 minutes; the undigested seeds are collected. They are coated with a film of sticky flesh from the berry and stuck to the perch. In due course they germinate and a new airborne plant springs up.

The thick-billed flowerpecker uses a second method. It does not swallow the seed but eviscerates the flesh away and wipes the seed against a branch or twig. The result is the same, however, the seed sticks to the branch where it germinates.

Pear-shaped nests

Flowerpeckers build small nests that hang from twigs. They are often pear-shaped with a slit-like entrance on one side. In the species that have been studied the female builds the nest by herself and incubates the eggs alone. The clutch varies from 4 to 5. Both sexes feed the young.

The diamond-birds build domed nests of dry grass, rootlets and bark strands like other flowerpeckers but they are often at the end of a tunnel dug in soft earth, in a bank or under the roots of a tree. Others nest in natural holes or crevices.

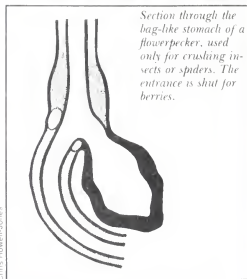
Bypassed digestion

The speed at which berries pass through flowerpeckers is most surprising. Within 5 minutes, often less, a berry is digested and the seed voided. This is managed by the in-



Right: Home in suspension. All by herself, the female has woven this neat pouch of a nest from grasses and rootlets and lined it with down.

usually shaped tract, which is also found in the other nectar drinkers. In most birds food first goes to the stomach, or gizzard, a strong muscular bag. There it is ground up by muscular action before going on to the intestine where it is broken down and absorbed into the body. In the flowerpeckers, as well as the honeycreepers, sunbirds and so on, the gizzard is a blind sac with one entrance instead of one at each end. This entrance can be closed by a sphincter muscle so berries and nectar are passed straight from the throat to the intestine. The passage of the berries is also speeded by the laxative effect of their flesh. The gizzard is used only when the flowerpecker is eating insects which need to be crushed.



Section through the bag-like stomach of a flowerpecker, used only for crushing insects or spiders. The entrance is shut for berries.

- class Aves
- order Passeriformes
- family Dicaeidae
- genus *Dicaeum*
- & species *Dicaeum hirundinaceum* mistletoe-bird
- D. agile* thick-billed flowerpecker
- D. erythrorhynchos* Tickell's flowerpecker
- Pardalotus punctatus* spotted diamond-bird
- others



Flowerpecker (family Dicaeidae)

Fluke

Some of the many kinds of parasitic flatworms known as flukes are of economic and medical importance, as well as being of fascinating interest to scientists because of the complexity of their life histories. These therefore will be dealt with at the expense of those that live comparatively simple lives on the skin or gills of fishes. Of the thousands of different species there are about three dozen that attack man, occurring particularly in the Far East, Africa and tropical America. They include lung flukes, intestinal flukes, liver flukes and the three species of blood fluke responsible for the disease known as bilharzia (schistosomiasis). Human flukes 4 000–5 000 years old have been found in Egyptian mummies, and the living counterparts are still exacting a heavy toll in north Africa, helped in places by irrigation schemes that have spread the water snails with which they are associated.

In Britain, an annual loss of tens of millions of pounds is caused through liver rot in sheep (bane, watery poke, bottle jaw) caused by the liver fluke *Fasciola hepatica*. Flukes take their name from their flattened shape. Many are leaf-like and all have suckers and/or hooks for clinging to their hosts. The adult liver fluke was compared aptly by William Cobbett to a miniature flounder in shape, about 1 in. long and $\frac{1}{2}$ in. across at the widest point. It has two suckers, one around the mouth, the other farther back on the underside. It lives attached to the wall of the bile duct and feeds largely by sucking blood, which causes anaemia in a heavily infested animal.

An egg every 4 seconds

The life story of the liver fluke is so involved and full of hazards that it is extraordinary any fluke survives. Indeed, it is only the production of incredible numbers of eggs and the occurrence of further reproduction by asexual means at various stages of the life cycle that enables the species to flourish. The mature fluke lives in a mammal. It contains both male and female organs and lays about 20 000 eggs per day, or one every four seconds. The eggs pass into the intestine in the bile and are then voided from the host. From those eggs which fall in suitable conditions come the first of several larval forms, called the miracidium. This must find another host, not a mammal this time but a water snail (species of *Lymnaea*, *Bithynia* or *Planorbis*) living at the edge of shallow pools and on moist ground. The miracidium swims rapidly by means of cilia covering most of its surface, and is attracted towards light and to chemicals released by the snail.

Bags of larvae

If it finds a snail it first grips with a sucker, then enters by digesting skin at one spot. As it enters, it loses its ciliated skin and becomes what is known as a sporocyst, a tiny living bladder that makes its way to the liver of the snail. Here, as it grows, a number of



Illustration: Anger

Fasciola hepatica (2 $\frac{1}{2}$ in. wide), showing the suckers by which they attach themselves. The oral sucker on the bottom fluke is for feeding.

elongated larvae called rediae are asexually developed within it, and eventually burst out. Inside each of these, a further 16–20 larvae, called cercariae, are produced, also asexually. Sometimes a second generation of rediae is interposed before the cercariae are produced.

Each cercaria, like the adult, has 2 suckers on the body, and a long tail for swimming as well. This stage, just large enough to be visible as a speck in the water, leaves the snail and attaches itself within an hour to a solid object, discards its tail and envelops itself in a viscous secretion, which hardens. In the next 2–3 days the cercaria secretes a second wall and transforms itself inside this 'cyst' into the 'metacercaria' which can survive heat, cold or drying up. This is as far as many cercariae get, for there is no further development unless the cyst is eaten by a suitable host along with the vegetation to which it is attached. Sheep are particularly likely to graze this vegetation but cattle, horses and rabbits are liable to infection, as well as man if he eats water cross not grown in proper beds. Man may be much more severely affected than a sheep by the same number of flukes.

With the help of the host's digestive juices, the young fluke gets out of the cyst and burrows through the wall of the intestine. In a few days it finds its way to the liver, bores in and spends the next 6 weeks bur-

rowing around in it. Eventually it enters the bile duct and, in a further 8 or 9 weeks starts producing eggs. Having triumphed over the rigours of the 'outside' world it can now continue its life, perhaps till the death of its host, without enemies and in a stable and favourable environment.

The life cycles of many other flukes are similar but with a few variations. The Chinese liver fluke *Clonorchis sinensis* needs a third host, the cercaria leaving the snail and entering a fish which must be eaten raw if it is to develop further. The schistosomes, or blood flukes, do not rely on being eaten. As cercariae with forked tails, they bore through the skin of man as fleas doles in infected water. 'Swimmer's itch', in this country, is due to penetration of the skin by otherwise harmless cercariae of another species. *Leucochloridium* infects thrushes when these eat the snail *Succinea* it is living in. The snail is made more conspicuous, so ensuring a bird will see it and eat it, when the fluke enters its body as a sporocyst. Infected snails seek the light and fall easier prey to birds.

Tangled webs of life

The life cycles of the liver flukes are extraordinary enough with their involvement of two or three quite different hosts, but some flukes actually pass through a fourth host during their development. Thus, after leaving its snail host, the fork-tailed cercaria larva of *Alaria mustelae* enters a tadpole or frog which must be eaten by a mouse. But before the adult stage is reached the mouse must, in turn, be eaten by a mink or weasel. Such a complex situation must surely have evolved from a simpler one and perhaps the ancestral flukes were parasitic only in snails, the most constant feature in all the present-day cycles. The addition to the life cycle of intermediate hosts between the snail and the final mammal or bird must have come about because they increased the chances of infection of the final host. This might seem improbable until one realises that animals cannot be considered completely apart from their environment and the other animals in it. In the case of *Alaria*, one stage, the mouse, may still be omitted if the mink should eat the tadpole or frog itself.

A common liver parasite *Dicrocoelium dendriticum* of sheep and other ruminants takes an even more tangled route to get home. Its larvae live in small land snails. The cercariae form masses in balls of slime in the breathing chamber of the snail. These in due course are carried out of the breathing chamber and fall to the ground. The balls of slime are gathered by ants and taken to their nests for food. The cercariae infect the ants, the ants are eaten accidentally by sheep as they crop grass, and this completes the life cycle.

phylum	Platyhelminthes
class	Trematoda
order	Digenea
genus & sp.	<i>Fasciola hepatica</i>

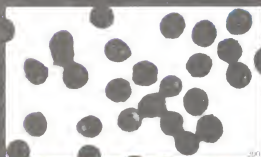
Liver fluke: subtle pastureland parasite

A complex but effective life cycle, illustrated below in a clockwise sequence, insures the adult liver fluke from the rigours of the outside world. But the fluke's ideal existence can be deadly for horses, cattle, and sheep.



M.J.D. Heenan

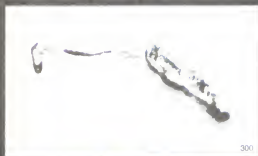
1. Specimen adult from infected animal.



8. The trap: metacercariae cling to grass.



2. Eggs, 20 000 a day, spread by faeces.



7. Out of the snail: cercaria larva.



3. Miracidia larvae, which infect snails.



6. Mud ruts spread snails – and flukes!



4. Redia larva reproduces inside snail.



5. Snail victim: larvae feed on it.

Both adult flukes (1) and eggs (2) are nearly impossible to kill, but waterlogged ruts (6) provide a place for mud snails (5) to breed. Snails can be controlled by poisoning their home, so the flukes within them never pass redia (4) stage. The miracidium (3) swims in ditches and on wet land until it finds a snail (usually *Limnaea trunculata*) and bores in through its foot. Inside, it changes to a redia (4). For 6–10 weeks this reproduces and feeds, leaving the snail as hundreds of minute cercariae larvae (7). The cercariae (7) reach grass blades by swimming with flailing tails and go into the fluke's infective stage – they form hardy cysts, the metacercariae (8). These wait (sometimes for months) to be eaten by a final host. Liberated in the stomach, they then go to the liver where they mature and produce millions of eggs to restart the cycle.

J. Alan Cash

Flycatcher

Flycatchers form a very large group of small perching birds that live in most parts of the Old World. Sometimes they are placed in a family of their own, the Muscicapidae, but nowadays they are thought to form just a subfamily, the Muscicapinae, which is placed in a family with other insect-eating songbirds such as the thrushes and warblers.

There are approximately 110 species of flycatcher, which range from the British Isles to New Zealand and Hawaii, most of them living in Africa or the Indo-Australian region. They share common features in structure although the colour of the plumage varies considerably. The paradise flycatchers are brilliantly coloured and have extremely long tail feathers. The bill is broad and flat and is

surrounded by stiff rictal bristles. Some have crests or wattles. They have short legs and weak feet, like most birds that rarely come to the ground. In view of the large number of species, this account will deal principally with the European flycatchers, which are the best known.

The commonest European flycatcher is the spotted flycatcher, found all over the Continent except the far north. It is also found in Morocco, Algeria, Tunisia, Asia Minor and southwestern Asia. The spotted flycatcher is an undistinguished-looking bird with mouse-grey plumage, lighter below with dark streaks on head and breast. More distinctive is the pied flycatcher. The female is drab and could easily be confused with a spotted flycatcher but for white bars on wings and tail. The male is similar, except in the breeding season when he becomes a striking black and white. His upperparts are black, except for white bars

on the wings and a white forehead. The underparts are wholly white. Pied flycatchers have a more restricted range than spotted flycatchers. They are found in about half of the British Isles and do not breed in most of France and northern Spain.

The two other European flycatchers are found only very rarely in the British Isles. The male collared flycatcher looks very like the pied flycatcher, and the male red-breasted flycatcher has an orange-red throat all the year. They are found in the eastern half of Europe, and the red-breasted flycatcher spreads across temperate Asia to Kamchatka.

On the increase

Flycatchers are woodland birds, usually seen in ones or twos perched on a twig, but some of the Madagascan flycatchers associate together, like tits. Many flycatchers are good songsters, especially those in Australia known as robins, but the spotted flycatcher

Wing pattern of a pied flycatcher, most distinctive of all flycatchers. In the breeding season the male does an impressive black and white plumage scheme.



has only a quiet song consisting of half a dozen squeaky notes.

Since the second half of the 19th century the pied flycatcher has been increasing in many parts of Europe. It has increased in northern Europe, and in northern Finland the population rose enormously after 1947. Pied flycatchers have gradually been spreading through Britain over the last hundred years. They now breed in many parts of Scotland, Wales and northern England. The reason for the spread is not known. It may be due to a changing climate or to the provision of nest boxes. Recently, pied flycatchers have become established in south Devon, and they appear to be dependent on nest boxes for breeding.

Pouncing on flies

The diverse group of flycatchers are united in their feeding habits. All live on insects which they catch in their broad bills, aided by the rictal bristles which act as a sort of net around the mouth. Many flycatchers can be

easily recognised by the way they fly out from a perch, catch an insect, sometimes with an audible click of the bill, and fly back. This is a very characteristic method of feeding and flycatchers can often be seen flitting to and fro during the summer. Each usually has its favourite perches on twigs or fence posts to which it returns after each foray. At other times they will hunt from the ground, catching the small insects flying over the grass. Some of the African flycatchers behave like shrikes, flying down to pick insects off the ground then returning to perches in trees or bushes. At other times flycatchers flutter among the foliage, picking insects off leaves and twigs.

Ardent courtship—and a double life

Flycatchers' nesting habits are rather similar. Many breed in trees or crevices in rocks. It is for this reason that the pied flycatcher has taken to nesting in nest-boxes in Britain and elsewhere, and it will also use old woodpecker holes. Both the pied flycatcher and

the collared flycatcher are polygamous, the male sharing his time between two or more mates, each of which nests in a separate territory. The male may, therefore, defend several territories against intruders. He may abandon the first mate to spend all his time with the second or, after initiating the second brood, return to his first mate to help her rear the first family. The females obviously do most work in rearing the chicks, and this is so even when the male flycatcher has only one mate. He does help a little with nest building, which is on a site of his choice.

The male collared flycatcher attracts passing females to his hole or other nest site by calling and fluttering about in such a way that his black and white plumage is conspicuous. So strong is his urge to display that he will continue to solicit strangers when his mate is away collecting nest material. The display is also very effective, for if the male starts to display at another hole the female will desert the eggs she laid in the original

Parental toil: collecting food for a nestful of hungry young is a full-time job. Here a pair of fiscal flycatchers buckle down to it.



nest and build another in the new hole.

The nest is made of moss, bark, lichen, rootlets and other soft materials woven together and sometimes bound by cobwebs. When not built in a hole or crevice the nest is placed in a tree, usually against the trunk. The clutch is usually of 6 eggs, though tropical flycatchers lay only 2 or 3, and some Australian species lay only one. The hen usually incubates the eggs alone, although the male brings food to her. In only a few species does the male incubate. Incubation takes about 2 weeks, after which both parents feed the young. When the chicks leave the nest they may stay with their parents for a while and can be seen hawking for insects together.

Begging for food

Feeding a nestful of rapidly growing chicks is a full time job for small birds. If one parent dies, the other brings twice as much food as it did previously. How does it know

that it must provide more? This happens all the time; as the chicks grow larger the adults have to bring more and more food. The stimulus controlling the adults' behaviour was demonstrated by a series of experiments performed with pied flycatchers nesting in a special box. The box was divided into two compartments, of which only one had an entrance. Six chicks were placed in the closed compartment and one in the other. The parents could hear the six but feed only the one. As they got hungry the calls of the six became louder and louder, and the parents brought more and more food to the single one until it could swallow no more. Even then, they continued to bring it food. Meanwhile other flycatchers arrived, attracted by the now frantically calling six. Once their compartment was opened they were, of course, soon well fed. This all shows that it is the sound rather than the sight of a hungry chick that stimulates the parents into collecting food.

There is a disadvantage to this mech-

anism. Noisy chicks attract enemies, but, perhaps in the long run, this may be a good thing. Normally the chicks call loudly only when food is short and the parents are having difficulty in feeding them, so we must presume a quick death from an enemy is better than slow starvation.

class	Aves
order	Passeriformes
family	Muscicapidae
genera & species	<i>Ficedula albicollis</i> collared flycatcher <i>F. hypoleuca</i> pied flycatcher <i>F. parva</i> red-breasted flycatcher <i>Muscicapa latirostris</i> brown flycatcher <i>M. striata</i> spotted flycatcher <i>Sigelus silens</i> fiscal flycatcher others

Precision flying: after a patient wait on a favourite perch, a pied flycatcher pounces. Below: A spotted flycatcher takes advantage of open brickwork.



Eric Hosking



John Manlyham



Disparately, reaching the water below, a flying fish struggles to get airborne. Scuffling across the surface with its tail to gain the speed, it spreads its fins for lift-off.

Flying fish

There are two types of herring-like flying fishes, the two-winged and the four-winged. In the first, only the pectoral fins are enlarged. In the second, the pelvic fins also are enlarged, making two pairs of wings, and it is this type that is noted for the virtuosity of its fins.

The commonest species is the two-winged *Exocoetus volitans*, 10 in. long, found in all tropical seas. The commonest four-winged flying fish is *Cypselurus heterurus*, 1 ft long, found on both sides of the tropical Atlantic. The largest four-winged type is *C. californicus*, 18 in. long, which in summer provides an attraction for visitors to California's beaches. In spring and summer it is fished commercially, most of the catch being used as bait for swordfish and tuna fishing.

Dangers above and below

Little is known about the biology of flying fishes apart from their journey through the air which have been the subject of much debate. When swimming, their long fins are folded against the body. They feed on plankton, perhaps also on small fishes, and in turn will be the prey of larger, predatory fishes, and also of seabirds. The flying habit must have evolved largely in response to heavy predation. Yet ironically, whenever a flying fish leaves the water for the air, seabirds, such as frigate birds, albatrosses and gulls, are liable to attack. Among the predatory fishes the main enemy seems to be the dolphin fish (p. 62).

Butterflying fishes

Flying fishes spawn on floating seaweeds and on other floating objects. Some seem to use sargassum weed almost entirely. On it they make nests by drawing the weed together with white elastic strings, and the eggs are fastened to one another and to the nest by similar but thinner threads. The young flying fishes are so unlike the adults that they have been described as different fishes. Besides being patterned in many colours, which prompted the American

oceanographer William Beebe to call them butterflying fishes, each young fish has a pair of large flap-like barbels, or whiskers, which hang down from the tip of the lower jaw. In the young Californian flying fish the barbels form a red, many-fingered outgrowth. In the young 2m-long Caribbean flying fish the barbels extend back beyond the tail, like streamers.

Flappers or gliders?

For many years it was hotly debated whether flying fishes vibrated their wings while in the air, or whether they merely glided. The reason why this doubt continued for so long was largely due to the fishes being so hard to photograph. Also there is an illusion of wing-flapping when the fishes are taxiing for the takeoff and are washed by waveslet. At this time also the rapidly moving tail vibrates the body and makes it quiver, so that the fins appear to be beating the air.

Studies of the anatomy, however, suggested that the fishes had the wrong muscles to be able to beat their wings. Experiments in wind tunnels pointed to the same conclusion. Finally stroboscopic photography showed conclusively that flying fishes are gliders, not true flyers. In stroboscopic photography a camera is used that makes repeated exposures at short intervals of fractions of a second. The pictures it takes show the successive positions of a moving object. The results are better than in a cine film, in which each separate frame gives a blurred picture.

Takeoff at 40 mph

To become airborne, the flying fish swims rapidly forwards and upwards to the surface. As its body lifts above the surface it spreads its fins and taxis along the surface with the lower lobe of its tail fin moving in a scuffling action. The lower lobe is longer than the upper lobe and is vibrated at a rate of up to 50 beats a second. After a short while the pelvic fins are spread and this gives enough lift to raise the tail fin clear of the surface and the fish is then fully airborne.

The average speed in the air is about 35 mph. At the start it is about 40 mph and this falls off to about 20 mph at the end as momentum is lost. The fish may land on its



Once aloft, the fish presents a perfect glider's silhouette. Flights can last up to 42 seconds.

belly with a splash, or it may dive head-down, drop back into the water tail first or even land on its back. If it lands tail first it may resume the scuffling action and taxi once more for another flight. Usually one or two flights only are made but there are records of up to 11 flights in succession, covering a distance of 1 000 ft or more. Each flight, or leap, may cover up to 450 ft and last about 10 seconds. The longest recorded lasted 42 seconds. Most flights are made just above the water but flying fishes have been known to land on the decks of ships up to 36 ft above sea-level. These higher flights may be when a fish strikes an up-current of air if the takeoff is into the wind.

The usual estimate is that 3 times out of 4 the fish takes off into the wind, but in 1965/6, NJB Plumley, of University College, London, made several journeys across the Indian Ocean, from the Red Sea to Australia, studying flying fishes disturbed by the ships he was on. He came to the conclusion that the direction and force of the wind had little bearing on the flights of flying fishes. What he did find was that they were less likely to become airborne if their course lay towards the sun than when it was away from the sun.

At times it seems that flying fishes have little control of their movements in the air but Carl Hubbs, distinguished American ichthyologist, maintained otherwise. According to him they sometimes fly straight towards the side of a ship and, when about to crash into it they suddenly plunge into the water, turn about almost directly, and make away in the opposite direction, either in the water or in the air. The four-winged flying fishes would have the advantage in such circumstances because their large pelvic fins act as ailerons for banking and as elevators for nosing down or for climbing.

class	Pisces
order	Atheriniformes
family	Exocoetidae
genus	<i>Exocoetus</i> , <i>Cypselurus</i>

Flying fox

Of about 4 000 species of mammals, nearly 1 000 are bats. Of these 160 are fruit bats. They differ from the rest in many important ways. The fruit bats as a whole will be dealt with under that title. The flying foxes are singled out here because they include 60 of the largest of the fruit bats, and also because they are a menace to cultivated crops.

Flying foxes belong mainly to the islands of the Malay-Indonesia archipelago but they are found eastwards in the Philippines and some South Pacific islands, southwards in northern Australia, westwards in parts of southern Asia, Mauritius, the Seychelles, Madagascar and the island of Pemba off East Africa. The largest is *Pteropus vampyrus*, which ranges from southern Burma to Vietnam through Malaysia and Indonesia to the Philippines. It is 1 ft long in the body, which is reddish-brown, and its black wings when fully spread span 5 ft.

Trouble in the camp

Flying foxes are really bats with fox-like heads, the resemblance being increased by the pricked ears and the ruff of fur around the neck. Their eyes are large. Unlike the insect-eating bats, which find their way about by using echolocation, flying foxes depend on sight. They roost by day in trees, in large numbers, of several hundreds to 10 000 or more, especially over mangrove or other swamps. These roosting places have been called camps. During the early morning, after the bats have returned from feeding, there is much fidgeting and moving. Although sociable, they like to keep their distance from their neighbours. When one flies in and lands too near another a fight begins. Even a falling twig may start a fight. The disturbed bat screams, lashes out with its clawed thumb, and snaps at its neighbour with its teeth. The fight ends, usually without bloodshed, when one of the contestants moves away. One fight may start a chain-reaction and in the end the whole roost is screaming and agitated.

Unhappy landings

It is easy to see how these disturbances can be started. Flying foxes are not always skilful at landing. They may fly heavily into foliage and then clamber along to a branch, or fly over a branch catching it with their hindfeet to fall into the hanging position, or do a half-roll under a branch to grip with the feet—or miss as the case may be. To take off, a flying fox must flap its wings until it has brought its body into the horizontal before letting go with its feet.

Later in the day most of them settle down. They hang by one or both feet, drop their heads onto their breasts, wrap their wings around and sleep. Since the flying foxes frequent the same roosts year after year their droppings foul the foliage so the upper branches of the trees are bare. The bats hang on these like grotesque fruits.

At sunset they begin to take off. At first a



ST. PAUL'S COLLEGE, BEANING



Flying foxes (genus *Pteropus*)

△ Flying fox of the genus *Pteropus* — only the head and neck of this bizarre creature could have earned it the name 'fox'. Tissue-thin flying membrane, claws, posture, the thumb on the wing — all these show that it is one of the only group of mammals to master true flight: the bats.



S. Diczball

S. Diczball

▼ *Myotis (mouse-eared) flying foxes pass the night being just squabbling in communal roosts*

▼ *Thief in the night, a grey-headed flying fox selects the ripest from among a banana bunch.*

△ *Fluttering confusion; a roost disturbed by an intruder, or by another bat's clumsy landing.*



Grigora Puzry / Photo Files

low stream up into the air, looking from a distance like wisps of smoke rising into the sky. As more and more take wing they look like a large black cloud as they fly around, screaming, before setting off for a distant feeding ground, perhaps as much as 40 miles away. The direction they take depends on what flowers are blooming or fruits are ripening. They have efficient noses and can detect these at great distances.

Fruit and flower harvests

Arriving on the feeding grounds they land on the branches and, hanging upside-down, draw the blossoms or fruit towards their mouths. They do this with one hindfoot, while suspended by the other, or with the clawed thumb on the angle of the wing. Fruits eaten include banana, pawpaw, guava and wild figs. Cultivated plums, pears and apples may be eaten, and much fruit is spoiled by biting or scratching. Flying foxes are reported to come down and land on pineapples. There has been much complaint from fruit growers, especially in northern Australia, about damage done by flying foxes. According to independent investigators the damage is probably overstated, although at times it may be high locally. One saving grace is that bananas, citrus fruits and others tend to be harvested while still unripe, for export to distant markets, and flying foxes take only ripe fruit. Moreover, it seems that flying foxes take wild fruits such as figs and berries, especially mistletoe, if these are available, in preference to cultivated fruits. Finally, it seems agreed that they eat a high proportion of blossoms and that fruit is only secondary in their diet. Some flying foxes have been recorded as eating so much mimosa blossom that they reeked of it.

Flying foxes have been reported as catching fish. It seems more likely that when seen flying down to the water they are drinking.

Nursing mothers keep together

For those species studied, the breeding season is February–March, with the babies being born about 6 months later. When pregnant the females occupy separate roosts or, when occupying a large camp several acres in extent, they form exclusively female groups within it. At other times the sexes mix indiscriminately in the camp. There is usually one baby at birth, sometimes two, and it is carried about by the mother for a month, clinging to her fur with its feet and holding a teat with its mouth, after which it is left behind at the roost when she goes foraging. The youngster can fly at 2 months, takes its first foraging flights at 3 months, becomes fully independent at 4–6 months and is sexually mature at 18 months. Flying foxes have lived for 17 years in captivity.

Food from the skies

There are a number of enemies, including eagles, the larger owls, large lizards and especially the goannas in Australia, and tree-climbing snakes. They do little more than keep the populations of flying foxes from expanding. Probably man is the more deadly enemy, especially in fruit-growing areas. Even he has some difficulties in coping with them. Fruit farmers shoot them and

sometimes poison them. This gives limited success but the lost hoards are soon replaced by new recruits.

People have been eating flying foxes since as far back as we can trace. Strabo, the Greek geographer, wrote that they served as food to people in the Euphrates valley. Aldrovandus, 17th century writer on natural history, records that the peoples of the South Seas eat large bats which tasted like chicken. In 1861 Sir Emerson Tennent stated that the people of Ceylon ate flying foxes and he was told by a friend they tasted like hare. Thomas Hutton (1872) confirmed Tennent's statement that the people of Portuguese Goa found them flesh delicate, and his contemporary Colonel Skyes testified to their savoury flavour.

Similar reports could be cited for Malaya, Java, Borneo and the Philippines, and in Samoa the flying fox is *manu lagi*, animal of

the heavens, but whether this implies a celestial quality or merely refers to their flying is uncertain. At all events the practice of the Samoans was to tie prickly branches for the end of a pole to strike the bats as they flew past. The Crooles of the Seychelles ate them and the Aborigines of Australia smoked them out. They lay fires under the trees to smoke the bats and knocked them down with boomerangs.

class	Mammalia
order	Chiroptera
suborder	Megachiroptera
family	Pteropidae
genera	<i>Pteropus</i> , <i>Neopteryx</i> , <i>Acerodon</i> others

✓ *Useless to man; flying foxes hang from the roosting tree; they have owned by years of use*





JANE BURTON. PHOTO BY

What's in a name? The flying gurnard (left), at best, a weak flyer, and is not a true gurnard. Both exhibit the aggression, despite the size, this is the Atlantic species.

Flying gurnard

There are two species of flying gurnard, one in the tropical Atlantic, the other in the Indian Ocean. Whether in fact they do fly is in doubt. Another problem is whether or not they should be classified with other gurnards, which they closely resemble.

The Atlantic species is up to 15 in. long. It has a large head and large, wing-like pectoral fins. It is greenish-blue with orange-edged dark spots on the head and body. The large pectoral fins are greenish-blue ornamented with the same orange-edged spots. The Indian Ocean species, up to 12 in. long, is a dull reddish with pink counterparts, blue spots down the back and a dorsal fin covered with brown spots. The pectoral fins are bright blue with brown and pale green spots. These descriptions of colour are, however, only approximate because in both species the colours vary with age as well as from one individual to another, and in any individual the colours vary somewhat according to what is happening. In the Atlantic species, for example, the young has a large white-edged black wellus or eye-spot on each of

the pectoral fins, and in the adults the colours, especially of the pectoral fins, become much more brilliant in moments of excitement.

Familiar—yet little known

Flying gurnards are familiar fishes on account of their colours and because in the Indian Ocean they are caught for food, from canoes fishing in deep water. Yet little is known about them. We know they are mainly bottom-living and that they feed on prawns and other small crustaceans.

A pugnacious fish

The flying gurnard swims slowly just off the bottom with its large pectoral fins laid back along the sides of the body. It may also crawl over the sandy seabed using the small lower lobe of each pectoral fin as a foot aided by the thin pelvic fins, which are said to be moved alternately like small legs. Skin divers report that when they approach to within 4 ft of one of the Atlantic flying gurnards it spreads its pectoral fins to the full extent and their turquoise-blue patches become brilliant. At the same time it grunts, with a noise not unlike a raucous version of the clucking of a barnyard hen. In the Indian Ocean the flying gurnard has many local names, all expressing that it makes

noises when caught in a net. After this show of bad temper the fish relaxes and folds its fins back along the sides. When the skin diver approaches to about 2 ft from the fish it does not swim away as other fishes do, but goes into an even more vigorous aggression, even advancing towards its adversary. A woman collecting shells in shallow water in the Caribbean met a flying gurnard. It spread its pectoral fins, came over to her and butted her ankles, which became numb immediately afterwards. It is suggested that the spines on the gill-covers may be poisonous, or perhaps it is the spine on the front of the dorsal fin which lies just behind the head. Certainly the fish is feared by the local people in the Caribbean.

Skilled at evading capture

Anyone trying to catch a flying gurnard with a net finds it very agile and skilful in evading capture, swimming away quickly. When caught and put in an aquarium it swings its body from side-to-side and it taps on the bottom with the hand-like lower lobes of the pectoral fins, tapping first with one 'hand', then with the other.

Do flying gurnards fly?

Those who maintain that the flying gurnard flies agree that its flight is more clumsy and less sustained than that of a flying fish. Dr PH Greenwood, distinguished ichthyologist, has described seeing Indian Ocean flying gurnards 'flying' out of the bow wave of a ship. About 4 in. long, their pectoral fins spanned 6 in. full spread, and he describes them as airborne for about 2 seconds. In that time, however, they seemed to be gliding in a controlled manner, not merely jumping out and plunging in again in the manner of other fishes. Opponents of this view argue that almost any fish will at times jump out of the water and it is quite accidental that the gurnard has large fins which act as planes to keep it airborne.

Near relatives?

Some students of fishes claim that flying gurnards and gurnards, which we shall deal with later, are closely related but should be kept in separate families. Others maintain they are not closely related and should be placed in separate orders, which is the view followed here. The two kinds of fishes differ in the bones of the skull. They also differ in the way the front spines of the pectoral fins are arranged, as well as in some of their behaviour. If they are not closely related then they give us a wonderful example of convergence in evolution—that is, of two kinds of animals that have come to look alike externally because they have the same way of life.

class	Pisces
order	Dactylopteriformes
family	Dactylopteridae
genus	<i>Dactyloptera volitans</i>
& species	<i>Atlantic flying gurnard</i> <i>D. orientalis</i> <i>Indian Ocean flying gurnard</i>

Flying lemur

There are 2 species of this living parachute, known as colugos or flying lemurs. Both are very alike and they have presented zoologists with a problem, for they have no close relatives. They are not related to lemurs, despite their name, and are placed in an order on their own between the insectivores (shrews, moles, hedgehogs) and the bats. Their teeth look superficially like those of the insectivores, they move about in the air like bats, and in face they look like some of the lemurs; but their teeth are unlike those of any other animal. Each of the incisors and canines has 2 roots and each of the lower incisors is comb-like, with 10–12 fine points.

One species is found only in the Philippines, the other is widespread through southeast Asia, from Burma to Borneo. It is cat-sized, 1½ ft long, with a tail nearly 1 ft long. It has a sharp muzzle and large eyes and there is a membrane of skin from the sides of the chin which continues in a broad web down either side of the body, taking in the forearm with all the fingers and the hindlegs and toes and going right up to the tip of the tail. The fur is a mottled grey, fawn and buff.

Ace glider

Only one kind of mammal truly flies: the bat. Many mammals make gliding flights and of these the flying lemur is the best equipped for it. It lives in forests and rests on the branches of tall trees in a vertical position, its body and gliding membrane lying close to the bark and harmonizing almost perfectly with it. Usually it chooses a hollow in the tree. When disturbed it moves rapidly along the branch, perhaps making its rasping alarm call, climbs up the trunk and launches itself in a long smooth flying leap to the next tree, anything up to 150 yd away. The efficiency of its parachute is such that it loses less than 40 ft in that long glide. Arriving at the next tree, it runs up the trunk to gain height, ready for another takeoff should that be necessary. It rarely comes to the ground and should it do so it makes for the nearest tree at the gallop and uses its sharp, curved claws to shin quickly up it. While sailing through the air the outline of the spread membrane is almost oblong.

Floral meals

At dusk the flying lemur glides to a favourite tree, and begins feeding on leaves, flowers and buds. It is said to eat fruit also, but one kept in captivity ate fruit only reluctantly. It pulls food towards its mouth with a front paw and bites off the leaves or flowers. Water is probably got from wet leaves.

Advanced offspring

Mating takes place in January to March and 60 days later the single baby—twins are rare—is born. The baby is 10 in. long at birth, ¼ the length of the mother. She leaves



Anticipation or retrospect? Watched intently by its baby, a female flying lemur licks her lips as she wanders through the foliage that forms the main part of her food.

it in a tree hollow when she goes foraging or carries it clinging to her teat or fur with its teeth, getting further support by grasping her fur with its clawed toes.

Rare or not rare?

For a long time zoologists believed the flying lemur to be rare, although the local peoples not only ate its flesh but used its fur to make hats. It was first discovered by Europeans in 1768 but it is only within the last 25 years that we have known it is common through out southeast Asia—when somebody discovered how to look for it. It is commonplace now that someone who is experienced in looking for a particular animal can readily find it, whereas anyone else can look and look and find nothing. It is a case of 'getting one's eye in'. It was the same story with the sloth, looked upon as rare until a GI stationed in the Panama Zone during World War II spent his free time looking for sloths and found that they were very common.

Too often an animal is called rare simply because nobody has looked for it in the right way. There was the scientist who, before going to Madagascar, was asked by a colleague to try to bring back specimens of a very rare fly. On arrival in Madagascar he

showed a drawing of the fly to the local people and offered a reward for every specimen they brought him. The following morning he was awakened early by noisy shouting, to find some Malagasy urging a cow towards his tent. The cow was swarming with flies—the rare fly!

class	Mammalia
order	Dermoptera
family	Cynocephalidae
genus	Cynocephalus volans
& species	C. variegatus





Flying phalanger

Sometimes called flying squirrels in Australia, because they look outwardly alike. Flying phalangers are, however, not even distantly related to squirrels but are true marsupials like kangaroos and opossums.

There are five species distributed over the eastern half of Australia, one species overlapping in the south into Tasmania, and one species of sugar glider in New Guinea. They belong to three types: the pigmy or feathertail glider, the 3 species of sugar glider and the greater glider. The first is mouse-sized, just over 6 in. long, of which a half is tail, olive-brown above, white below. The sugar gliders are nearly 16 in. long, of which one half is bushy tail, with a fine silky fur, grey to brown with a dark line along the back and lighter underparts. The greater glider is over 3 ft long, of which the tail is over 1½ ft, grey to dark-brown with yellowish underparts. All live in trees and take gliding flights from tree to tree. The gliding membrane of the sugar glider is narrow, fringed with long hairs and stretches from the fore to the hind limbs. In the others this "parachute" is a broader web of furred skin stretching from the 5th toe on the forefoot to the ankle of the hindleg. In the sugar glider the tail is feathered—that is, fringed either side with long hairs; in the remainder it is bushy.

Hidden in the tree tops

The feathertail flying phalanger, or glider, has the large eyes and ears typical of a nocturnal animal. It is seldom seen except when a tree is felled or a domestic cat brings one home. During the day it rests curled up in holes in trees, up to 50 ft from the ground, lying hidden in a nest of shredded eucalyptus bark. At night it takes gliding flights from tree to tree. It is said to be common wherever there are eucalyptus trees and especially those with a white smooth bark. In the trees it runs quickly over bark using its claws, and it can run over smooth leaves with the pads on the tips of the toes giving a sure grip.

The habits of sugar gliders and greater gliders are similar. When in the tops of the trees there is little to indicate they are moving about except a faint scratching on bark or the rustle of leaves. Their glides also are sudden and swift, usually seen only by accident. The gliding leats are most spectacular in the greater glider; one is recorded as having covered 590 yd in 6 successive glides, an average of nearly 100 yd between each pair of trees. During a glide the phalangers lose height, and having landed on the next tree they run rapidly up the trunk for the next takeoff. Sometimes one will land on the ground, over which it runs awkwardly.

All have a sweet tooth

The various flying phalangers differ in one respect: the teeth. The pigmy gliders have insectivorous teeth, recalling those of shrews. They eat insects and especially



Left: A sugar glider takes a snack. These pretty marsupials eat almost anything they can get.

△ Takeoff; a well-judged launch into space . . .
▽ . . . and landing, gripping with sharp claws.



plant lice, such as aphides and scale insects, that give out honeydew. The sugar glider also eats insects, and small birds as well, but its food is mainly flowers, fruit, buds, nectar and sap. The greater glider feeds only on leaves and flowers, mainly those of gum trees. Both these have the kind of teeth associated with a vegetarian diet.

Useful mobbing

Being marsupials, the females carry their young in a pouch, and when the babies are large enough to leave it they ride on

the mother's back; at least this is true for the smaller species. This is known from only chance observation, as when a flying phalanger, out in broad daylight, was mobbed by a crowd of birds, including Australian magpies. One of these swooped and drove the phalanger hard against a tree. It hit its head on a branch and fell to the ground, where the baby fell from its back. Otherwise little is known of the breeding habits of these shy creatures. The pigmy glider has 2-4 young at a birth. The sugar glider has 1-3, usually 2, babies after a gestation of

A. POOR, OZARKS

A. POOR, OZARKS

3 weeks, the young becoming independent at 3 months. The greater glider has one young in July-August, which leaves the pouch at 4 months, but remains with the parents until fully grown.

Powerful owl enemy

The greatest hazard to flying phalangers lies in the steady felling of eucalyptus or gum trees. A phalanger occasionally falls victim to the introduced red fox when it lands on the ground. Otherwise the main enemies are owls, especially the one known as the powerful owl.

Bundles under the tail

Several marsupials use their tails for carrying nesting materials, and so does that other primitive mammal, the platypus. This is the more remarkable since the tail of a platypus is not long and slender but broad and flat—less suited, one would have thought, to being wrapped around a bundle of leaves. The rat kangaroos of Australia do the same, but their tails are prehensile, anyway. The American opossum brings its tail forward under the body, passes leaves and grass—or similar building materials—backwards

under its chest, then with its hind legs arranges these for the tail to grasp. The greater glider has been recorded as carrying a bundle of twigs and leaves for a nest with its prehensile tail, and sugar gliders have been seen to do the same.

David Fleay, the Australian naturalist, watched a captive sugar glider hang by its hindfeet, bite leaves off eucalyptus boughs and, using the forepaws, transfer them to its tail. When it had a bundle about 6 in. long and 3 in. across, the phalanger ran along to its nesting box holding the bundle with its tail wrapped round it.



Flattened, fur-clad skydivers

Below left: Sugar glider feeding on foliage. The folds of skin between the limbs give little idea of the massive 'parachute area' so dramatically illustrated below. The neatly-curved tail can be used for carrying nest material; Below: Study in unpowered flight. With only a leap from a tree trunk and the gliding effect of the outstretched skin, a flying phalanger can average 100 yd a trip, landing with remarkable accuracy some way up the trunk of a selected tree.

phylum	Mammalia
order	Marsupialia
family	Phalangeridae
genera	<i>Aerobates pygmaeus</i> <i>pygmy glider</i>
& species	<i>Petaurus australis</i> <i>sugar glider</i>
	<i>Scolinobates volans</i>
	<i>greater glider</i>

▷ *Baby phalanger, blind, naked, and completely helpless, nestles in its mother's pouch. It will not become completely independent until about 4 months' old.*



© David Johnson



Flying squirrel

A squirrel making a seemingly miraculous leap from one tree to another is a common sight, but flying squirrels make proper flights, gliding from tree to tree.

There are 35 species, of which one is Arctic (Arcticum), one extends from southern Sweden through Finland and Siberia to Japan, and the rest live in another wide mountain zone. All are similar in build and habits and all possess sets of spread

dark skin or sepia fur, its tail feather-like and its flying membrane fringed with stiff hairs. The other Asiatic species are mainly around 2 ft total length, sometimes richly coloured, and varying from rufous to cream-coloured.

The only species whose biology is at all well known is the North American flying squirrel, and this is the one to which the name was originally given, by Captain John Smith who in 1624, in his *Generall Historie of Virginia*, wrote: 'A small beaste they have . . . we call them flying

Living magic carpets

Except during cold, wet and windy weather flying squirrels come out to feed at night, and travel from tree to tree by gliding with the four legs spread to stretch the flying membranes. On landing, a squirrel immediately races round to the other side of the tree, a precaution against attack from a predator while still recovering from the landing. Then the squirrel rapidly climbs to regain height lost in the glide. They rest by day in hollows in trees and will also use roof spaces, outbuildings and bird nesting-boxes. Occasionally the nest will

... with the greatest of ease: glide-in, braking and touchdown, all masterfully handled.



© PHOTOFEST/ALAMY

skin on either side of the body, extending from the foreleg to the hindleg and ending on the tail. The largest is the common giant flying squirrel of Asia (India, China, Taiwan to Indonesia), yellowish-grey to black above, white to yellow on the underside, measuring 4 ft overall. The next largest is the Kashmir giant flying squirrel, nearly 3 ft total length with soft, woolly greyish-fawn fur and a bushy tail. The smallest is the pygmy flying squirrel, of Malaya-Borneo, 5½ in. total length, with

squirrels.' Surprisingly, little is known of the habits of the so-called European flying squirrel (Sweden-Japan), but in size and appearance it is similar to the North American species, with its brownish coat and white to cream underparts, large eyes and small ears. The North American species will be dealt with here, and regarded as typical of the 35 other species. The North American flying squirrel is regarded by some zoologists as having two species, a southern and a northern.



be made on leafy branches, like the drey of tree squirrels, but more cosily lined. A nest is made of dry leaves, shredded bark, moss, leathers, and fur.

Their normal call is described as 'chuck-chuck-chuck' which changes to a squeal when the squirrel is alarmed or aggressive. At other times a musical chirping, sometimes slightly harsh, is used. It seems that some of their calls are in the ultrasonic range and it has been suggested that flying squirrels may use these (to a more limited extent) as bats do: to detect obstacles.

Impressive drinkers

The food of flying squirrels everywhere is much the same as that for the North American flying squirrel, which is nuts, seeds, fruits, lichen, fungi, bark and insects. Birds' eggs and small birds are sometimes taken. Food is hoarded by the North American species, which does not hibernate. It also is reputed to be a heavy drinker, so it locates itself near water. Will Barker, the American naturalist, claims that a flying squirrel will drink each night the equivalent of 2 gallons for a man.

Illar Muul has investigated the factors

This coincides with the opening of the autumn harvest of nuts.

Nuts may be buried under leaves on the ground or pushed into cracks and crevices in trees. In the first the squirrel parts the leaf litter with its forepaws, pushes the nut between its hindlegs and, with tail erect, hammers it down with several blows of its snout. Nuts put into cracks in bark are hammered into place with the bare front teeth.

Illar Muul also investigated why, when the hoarding instinct is at its height, a squirrel makes no attempt to pick up nuts pro-

troups go into a state of semi-torpor in which all activity declines.

Birth of a glider pilot

Breeding is from February to March or even later. After a gestation period of 30 days or more a litter of 2-6 is born. At birth the babies are naked, pink and blind, 2 1/2 in long and weighing 1/16 oz. The eyes open at 25-28 days. Weaning begins at 3 weeks.

Because they are almost wholly nocturnal the flying squirrel's main enemies are the tiger owls.



that stimulate the hoarding of food. The favourite nuts of the North American flying squirrel are hickory nuts, with acorns second. In a good crop year 90% of its food will be hickory nuts. Some hoarding goes on at all times, fewer than 20 nuts a night in summer rising to a peak of 270 a night in November. The more intensive hoarding begins in mid-September, reaches a peak in November and drops back to fewer than 20 by mid-January. Tests suggest that it is the shortening of the period of daylight that triggers off the increased hoarding,

visually hoarded although it can see them. He suggests, as a result of his tests, that a secretion from glands on the infolded lips 'marks' each nut as the squirrel picks it up and carries it away to hoard it. Thereafter, such 'contaminated' nuts are ignored during the height of the hoarding season.

Another feature of the shortening day is that flying squirrels tend to rest in groups of up to two dozen in one nest. This is an advantage in that all keep warmer, but it also tends to make the hoarding a communal effort. During periods of bad weather these

Flight or gliding?

Those who write about animals are very ready to point out that the term 'flying squirrels' is a misnomer, that these animals do not truly fly like birds or bats, but only glide. This is apt to be misleading. The real difference is that in birds and bats we have *powered* flight, whereas in flying squirrels we have *controlled* flight without wing beats. To suppose they merely glide or parachute from tree to tree is far from the truth.

Before becoming airborne a flying squirrel

leans its head first to one side then to the other, possibly moving it up-and-down as well. In this, it is using a form of triangulation to judge the distance and direction it must travel to its landing spot. When it does finally land it does so accurately on the chosen spot. This line is not accidental as seen when a flying squirrel is disturbed and takes off hurriedly without assessing where it is going. It is then likely to land on the ground or even in water.

Just before landing the squirrel erects its tail, causing its head and body to rise vertically. This brings all 4 feet accurately on

trudde! A spur on each wrist joined to the flying membrane can be used to tighten or slacken the membrane. By dropping the legs of one side, to give added lift to the membrane on the other side, the squirrel can bank or turn sharply. It can also dive steeply and use the speed to rise steeply at the end of the dive.

Although most glides are simple, from one tree to another in a direct line, flying squirrels have been seen to make right-angled turns, lateral loops, spiral ascents and other acrobatics. They have even been seen to change their minds in mid-flight, turn com-

signalling whether to follow her, or stay while she makes an exploratory flight.

class	Mammalia
order	Rodentia
family	Sciuridae
genus & species	<i>Glaucomys volans northern</i> <i>G. sabrinus southern</i> <i>North American flying squirrels</i> <i>others</i>



to the 'landing strip' to cushion the force of impact evenly, so the braked landing is gentle and the clawed toes are ready to grip the surface.

At the start of the flight, after deciding where it will make for, the squirrel leans forward, pushes with its hind legs and spreads all 4 legs at right angles to the body so the flying membranes on the 2 sides nearly form a square. It is then almost like a sheet of paper dropped horizontally from a tall building, but with more control.

The tail can be used as a balance and a

pletely around and land again on the exact spot from which they had just taken off.

The babies begin by making short flights at about a month old. Should one fall the mother will respond to its distress cries by flying down and retrieving it, picking it up by its membrane on one side with her mouth. At 6 weeks glides from branch to branch will be attempted, but for journeys from tree to tree the mother must coax her baby. Apparently she does much to train her offspring in the early stages, directing movements by signals, and especially

△ *Tense moment: an American flying squirrel prepares for its next glide. By cocking its head from side to side it judges distance and direction; then, extending its legs to spread the membrane and kicking off with the hindlegs, it leaps into space. The bushy tail and the spurs on the wrists are its controls: the tail forms a rudder and the spurs kink the membrane for turning and banking. An agile flier, its repertoire includes acrobatics like spiral ascents and flat loops. ▷ A flying squirrel at its night feeding, firmly suspended by the 'safety belt' fastenings of its sharp claws.*





Anthony Myrland

Fodi

Fodi are *weaverbirds*, a large group of birds that only includes the *sparrows*. The few species not put into restricted islands in the species *Foudia* group, including Madagascar, the Seychelles, Aldabra, Mauritius and St Helena. The birds that have been studied in detail are the *toq toq* of the Seychelles and the *Madagascar cardinal*. The latter is named after the flaming red plumage of the male. The females and immature males have dull green-brown. Both sexes of the *toq toq* are dull coloured, but the male has a few white markings on the face.

Different ways of life

The weavers are particularly interesting for several reasons. In Africa the species exists in flocks of millions and is every serious pest of crops, but apart from their economic importance, they are scientifically interesting because they fall into very distinct groups: seed eaters and insect eaters. The differences between the groups are reflected not only in the diet and in the modifications in bill shape to eating fibres, but in almost all aspects of their social life. Seed eaters live in flocks and nest continually, while insect eaters do about in small family parties and such pair nests alone. Social life is probably related to feeding habits, and insect eaters need more space in which to find their prey, whereas species living off the seeds of grasses have a virtually unlimited source of food, so that dense flocks are easily fed.

The Madagascar cardinal and the *toq toq* are studied by John D. Dool of the Seychelles. The *toq toq* is a bird that now survives on only three islands of the group, and the cardinal was introduced from Madagascar in the last century and is

now widespread. The two belong to the different groups of weaver. The *toq toq* is a dumpy bird with a narrow, pointed bill used for catching insects. It lives in forests, where it is seen in family parties. The cardinal is smaller and lurch-like. It lives in open savannas, is a seed-eater, and lives in flocks. On the three islands where the *toq toq* survives, the two closely related species can co-exist without competition because of their widely differing habits. The *toq toq* lives in the remaining original forests or in the coconut plantations that have replaced them, while the cardinal lives in brush and grass clearings and in cultivated country.

Insects and seeds

There is a slight overlap in the feeding habits of the two species. The cardinal takes a few insects, mainly for its chicks, and the *toq toq* sometimes eats seeds or roting fruit. The two birds are also seen together in large numbers feeding on the drying crops of coconuts.

*Toq toq*s can catch insects on the wing, but more often they can be seen examining the broad leaves of coconut palms for small insects and spiders. Banana flowers are carefully searched by separating the flower clusters with the bill and catching any insect that has sought refuge in between.

Pairs or family parties

Outside the breeding season the *toq toq* fly about in pairs or in family parties, calling to each other to keep in contact. In the heat of the day they bathe in groups, and they huddle together when roosting. Breeding takes place throughout the year, but mainly in the rainy season. The pair defend their territory against other *toq toq*s, chasing them beyond the boundaries. Cardinals are also chased, but usually where territories of the two species overlap they manage to avoid each other. The cardinal territories are

much smaller and the nests of different pairs are closer together. Moreover, the female cardinal is not such a close partner of the male as is the female *toq toq*. The male cardinal leaves the flock, establishes a territory and builds his nest and only then is he joined by the female.

Fodis, like other weavers, make nests of woven grass and fibres. From which the name weaver is derived. Some weavers build very elaborate nests, but those of fodis are relatively simple. They are usually built woven onto twigs or fronds, with a porch over the entrance. As with other weavers, the first stage in nest-building is to construct a ring of fibres, woven onto twigs in the case of the *toq toq*, or suspended in the case of the cardinal. The main structure is then added by loose weaving. This takes the birds quite a long time and when the eggs are first laid they can often be seen through gaps in the nest. The usual clutch is 2-4 eggs, which take about a fortnight to hatch.

Both parents feed the chicks on insects, with the young cardinals being fed on seeds as well.

Introduced threats

The *toq toq* has become less common partly because of the cutting down of its native forests and partly because of the cats, rats and mice which have been introduced. The cats and rats, however, probably have difficulty in reaching the suspended nests among the finest twigs and foliage. Snakes, and perhaps geckoes, raid the nests. Adults are probably captured by the falcons and owls that live on the Seychelles.

Moving house

In their native land the Madagascar cardinals build their nests in low bushes and only rarely are they found in palm trees. In the Seychelles, on the other hand, palms supply the main nest site. This is an adaptation to a new environment, but it is not complete. In his study in the Seychelles, Crook found a high proportion of cardinal nests had been dismantled or abandoned. The cardinals were taking a very long time to build their nests, up to a month, and sometimes the males dismantled them neatly, carrying the material to other trees where they were rebuilt. It seems that the female cardinals are reluctant to accept the nests, and that the males have difficulty building them, because they have not become fully adjusted to the new habitat, high in the palms rather than low in the bushes. Removal and rebuilding of a nest has been reported in cuckoo shrikes (p 590), as a result of disturbance. Perhaps in both birds it is uncertainty, either because of disturbance or unnatural surroundings, that leads to this kind of rehousing.

class	Aves
order	Passeriformes
family	Plocidae
genus	<i>Foudia madagascariensis</i>
& species	<i>Madagascar cardinal</i> <i>F. sechellarum toq toq, others</i>

Foram

Even scientists, who seem to the layman to revel in the use of long words, customarily speak of the *Foraminifera* by this shortened version. The full name means pore-bearers and most forams live in shells perforated by many tiny holes or pores.

Forams are found only in the sea. They are protists related to amoeba (p. 34) and like it throw out temporary processes of protoplasm known as pseudopodia, or false-feet, slender strands of protoplasm coming out through each pore, as well as through the mouth of the shell itself. Outside the shell the strands branch and run together to form a network. This not only helps buoy up the foram but also serves as a snare to trap food, minute animal life in the plankton even smaller than the forams themselves. The shells of most forams are limy, others are made of a substance called tectin. Some build "houses" around themselves of things such as sand grains. They may be $\frac{1}{16}$ in. across or less, or they may be, as in the fossil Nummulites, several inches across. There are more in tropical seas than in the colder seas.

Building skills

The shells of forams are formed by the animal, in this case a microscopic animal with a body that is little better than a single cell, from lime salts extracted from seawater. This is then given out, and crystallizes around the body. The shells so formed differ in shape from one species to another. Some look like very tiny mollusk shells, others are spheres variously decorated with knobs, or they may look like bean-pods, stars, triangles or exquisite flasks. Usually each shell is made up of many chambers. The young foram builds its first tiny shell then later adds another, slightly larger chamber. This goes on repeatedly with each new chamber larger than the last.

Some forams live on the seabed and surround themselves not with a shell but with a coat of foreign material. This may be the broken spines of sea-urchins, broken sponge spicules, the plates from the skin of sea-cucumber or just sand grains. The shells already described command our admiration for their beauty. The coats made of foreign materials compel our admiration for the skill with which they are put together.

Whether the foram is using sponge-spicules or sea-cucumber plates, or anything else, it selects from the debris of the sea floor only that one kind of material. It also picks up only pieces of similar size. Having done so it arranges these in an orderly fashion so they lie alongside each other with out overlapping and, if necessary, grades them for size. In fact, it is not too much to say that the microscopic foram works with no less skill than a person who puts a jigsaw puzzle together using two hands and ten fingers. Moreover, that person has a brain, specialized sense-organs and the ability to think. A foram is only a small mass of proto-

plasm with several nuclei, so there is no brain, nerves or special sense-organs. Yet there is a fine ability to select and build.

External digestion

The food trapped in the web-like snare formed by the pseudopodia is not carried into the recesses of the shell to be eaten. It is digested outside the shell by the pseudopodia. The nourishment so obtained then passes along the inner protoplasm of the pseudopodia into the main body.



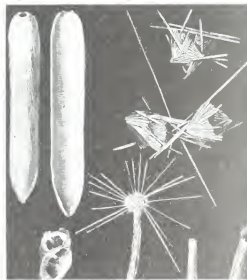
The shell of a living foram.

Broods of baby forams

The way in which forams reproduce is probably much the same in the many thousands of known species, but has been closely studied in very few of them. It is mainly asexual. In a typical case a "blob" of pseudopodia appears around the shell of a foram and a few hours later these are withdrawn and "young" forams can be seen leaving the shell. They consist of a hundred or more very tiny rounded blobs of protoplasm. Within an hour each new young foram has surrounded itself with a shell about $\frac{1}{4}$ the diameter of the parent shell which sinks towards the bottom of the sea.

At intervals sexual reproduction takes place, of a very complicated pattern. It is sufficient here to note that it does take place. To go into further detail would involve specialist study.

*Jigsaw builders: forams construct a remarkable range of homes. Left: A selection (p. 26). Right: *Fantasia* building detail over the center piece (p. 180).*



Rock-builders

The main interest in the forams for most people is the part they have played in the rock formations of the continents. The best example is that known as chalk, of which the White Cliffs of Dover are an obvious example. They are a prominent feature of the south coast of England. Another is the chalk beds of the Mississippi Valley in the United States, 1,000 ft thick.

As the shells of forams become empty they sink to the bottom of the sea and in many places in the ocean depths of today vast areas are covered with their shells. It has been calculated that these deposits accumulate at a rate of slightly less than $\frac{1}{16}$ in. per thousand years, which gives us some idea of how long it took for the Dover cliffs and Mississippi chalk beds to form before they became dry land.

As already indicated, some forams now extinct were large, then shells commonly an inch or more across in some species several inches. These have formed the rocks prominent across North Africa. They form the Atlas Mountains and they produced the rocks which built the pyramids.

The lure of oil

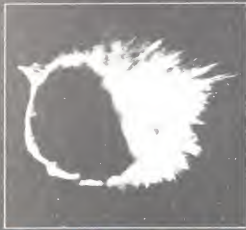
In the modern world the forams of past ages have assumed a great importance. The study of fossil forams was at first of purely academic interest. Then, suddenly, the study took root when it was found that fossil forams were a guide to where the petroleum deposits lay. They helped to indicate where borings should be made for oil.

This was quickly followed by an entirely different field of study, when oceanographers learned to take borings of the ocean bed. From the strata in these sections the history of the oceans could be worked out. The kinds of forams they contained enabled the geologist to plot the changes of climate that had taken place over millions of years.

phylum	Protista
class	Rhizopoda
order	Foraminifera

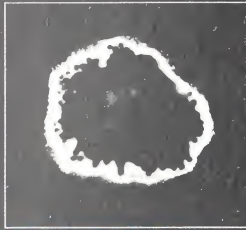
Foram multiplication

Although members of the phylum Protista are made of only one cell, it would be wrong to dismiss them as simple; they range from the primitive to the advanced. Reproduction especially can be quite complex but one basic principle stands out: a parent body splits up to form new animals. The remarkable series of photographs below show the stages in the reproduction of the foram *Elphidium crispum* ($25 \times$ life size).



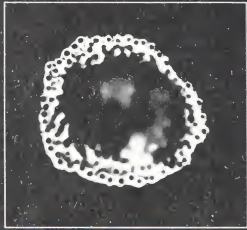
Phase One: Preparation

A halo of pseudopodia appears round a foram shell, which is packed with nuclei. From each parent will, one many young, each formed from one of these nuclei. This high reproductive rate is essential for planktonic animals, for they form the bulk of the food of many sea animals—and their losses are fantastic.



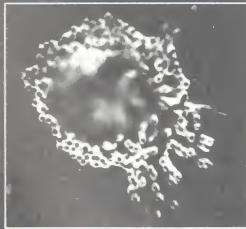
Phase Two: Heading for the open

After 5½ hours the halo fringe is withdrawn and the young forams make for the outside, each of them wrapped in an envelope of protoplasm. Here the nuclei show clearly as black dots. Forams do not mate in this type of reproduction; each nucleus carries an identity of building, out, passed on from the parent.



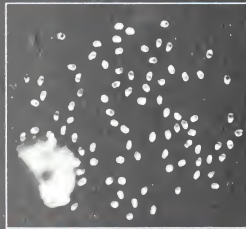
Phase Three: On the threshold

About 4 hours later, all the young forams have left the parent and are grouped around the shell, each with its portion of the original protoplasm. By now the parent is so drained that light can clearly be seen filtering through its shell. Yet the parent has multiplied itself into immortality rather than dying.



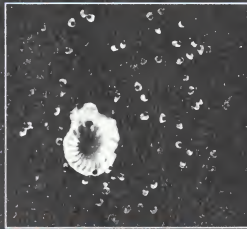
Phase Four: Breakout

The departure of the young is an explosive affair, taking place about 20 minutes after the final grouping around the edge of the parent's shell. At this point their structure is simple, but they will grow rapidly, and as the shell develops it becomes more elaborate, with the chambers appearing one after the other.



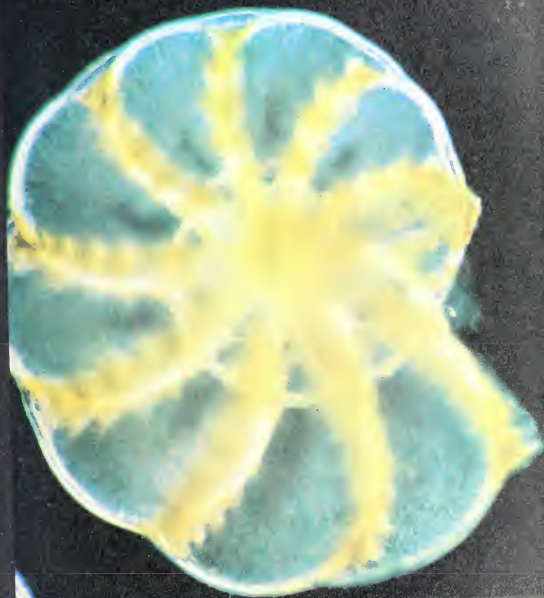
Phase Five: Dispersal

The young start to scatter 35 minutes later, already functioning as individuals. They have secreted the first chambers of their shells, which show dark with the nucleus inside. The first of the spiral chambers project quite clearly from the edge of their bodies, while the parent is now an exhausted skeleton.



Phase Six: Exhaustion and death

The demands of the young have completely emptied the parent of its protoplasm. It is now a mere husk, ready to sink to the ocean floor to form part of the deep-sea ooze or the familiar sand on beaches. The colourful foram corpses at right show the spiral chamber divisions (septa) and the partitions which run across them.



Surrounded by legend and confused in ancestry, the fossa is Madagascar's largest carnivore.



© David Phillipps

Fossa

Which is more frightening to the fossa is being chased by local superstitious and superstitious natives? It is the largest carnivore in Madagascar and although it is not uncommon to find fresh tracks of fossas there is very little real information on its habits. The fossa resembles an appearance and goes on, classified in the cat family, it is now placed in a separate subfamily of the Viverrinae (order: geniviverridae). It was first described from the discovery of both teeth and excreta. The claws are curved, sharp and can be retracted like those of a cat, but fossas walk on the sides of their feet like horses, rather than on their toes like cats. The head and body measure 2-2.5 ft and the short tail is a long again. The fur is short, soft and glossy, usually reddish-brown, but sometimes black fossas are found. The head is cat-like, but with a longer snout. The whiskers are very long and the eyes retract. One of the many legends about fossas is that they can contract the pupils of their eyes until

they have disappeared completely. This story has occasionally been accepted by zoologists. Fossas can close their pupils to slits like cats, and sometimes the eyes appear opaque, as if the fossas suffer from cataracts. This could have given rise to the story.

Unfortunately the scientific name *Fossa fossa* has been given to the Madagascar civet also belonging to the Viverridae. The fossa is *Cryptoprocta ferax*.

Night hunter

Fossas live in the forests of Madagascar where they lead a nocturnal and solitary existence, being the Malagasy equivalent of cats both in form and habits. Their main prey seems to be lemurs, which they chase through the trees. No doubt they also catch birds, for they are unpopular with local farmers because they take domestic chickens and ducks. One farmer has reported losing 25 chickens in one night. Each one had its neck bitten. There are also reports that they will attack wild pigs and even oxen. Although stories of the fossa's ferocity are often exaggerated, they have occasionally been trained to help hunt water hogs.

They may attack man

During the breeding season fossas become less solitary and small bands can be seen roaming together. During this period they may be dangerous to man, turning on anyone who disturbs them, rather than fleeing. The usual litter consists of two or three. Nothing is known of their family life, but it is hoped that fossas will soon be bred in zoos.

Skunk-like odour

Being the largest carnivore in Madagascar, the fossa has little to fear from any animal except man. Like some other viverrids, fossas can secrete a disagreeable skunk-like odour from glands at the base of the tail when they are irritated.

Forest ghoul

It is surprising that the fossa should have attracted so many legends, unless it is because it is the only large Malagasy flesh-eater. Each tribe in Madagascar has its own legend about the fossa which almost always portrays it in a bad light. It is generally regarded as being very brave and very wild but the legends credit it with a highly distasteful personality. The fossa's scent is said to kill poultry; it is thought to creep into houses at night to steal babies from their cots. Worst of all in one district people will not sleep in the open as fossas are said to lick their faces, putting them into a trance and while in this state they are disembowelled.



© David Phillipps

class	Mammalia
order	Carnivora
family	Viverridae
genus	
& species	<i>Cryptoprocta ferax</i>

Legend has it that a fossa can contract the pupils of its eyes until they disappear; here it reacts to unaccustomed bright light by reducing them to mere pinpoints.

Four-eyed fish

This remarkable fish has two eyes each divided into two. Even more remarkable, 'left-handed' males must mate with 'right-handed' females and vice versa.

A minnow-like fish, 6–8 in. long, sometimes reaching 1 ft, it lives in freshwater from southern Mexico through central America to northern South America. It is long-bodied with a rounded tail fin but otherwise undistinguished in shape except for its large goggling eyes. It spends most of its time cruising at the surface with only the upper half of each eye above the water.

Divided eyeballs

Each eye of the four-eyed fish is divided horizontally by a partition, and the fish swims with the surface of the water level with this. The partition divides the cornea. Anything underwater is seen by the upper retina through the lower cornea. Vision through water requires a thicker lens than vision through air, so the lens is oval, and anything viewed underwater is seen through the thicker part of it.

Land animals have a tear duct to keep the eye moist but the four-eyed fish has to dip its head from time to time to keep its eyes from drying out.

Looking for prey

The four-eyed fish feeds on small swimming animals. It would be reasonable to suppose that with the double vision it could look for food under the surface and also for any insects falling on the water. This, however, seems to be in some doubt. Its usual way of feeding is to swim down, catch its prey, then immediately swim up to lie once again just under the surface with half of each eye above the waterline. We can only suppose also that its aerial vision helps in keeping watch for enemies from above, such as water-birds.

Compatible marriage

The females bear between 1–5 living young. One female 6 in. long gave birth to one baby 2½ in. long, and another of similar

size gave birth to 4, each of which was 1½ in. long. Fertilisation is internal; the male must inject his sperm into the female. He does this using a tube formed from modified rays of the anal fin. In any male this tube can only be moved either to the left or to the right.

The sexual opening of the female is protected by a special scale, so it can be entered only from the left or from the right. As a result a 'left-handed' male can mate only with a 'right-handed' female, and vice versa.

Bifocal blenny

Anableps anableps and *A. tetraphthalmus*, the two species of four-eyed fishes so far discussed, are not alone. There is a four-eyed blenny, ¾ in. long, living on the rocky shores of the Galapagos Islands. Its eyes are divided by a vertical partition, and for a long

Two-tier vision: the compound eyes of the four-eyed fish scan both air and water.



time we have been told that this blenny spends much of its time in a vertical position with its nose out of water and the partition in the eye coinciding with the waterline. In 1965, however, the German zoologist Theodor Gatto, studied this blenny *Danioanableps* at first-hand in the Galapagos and found it does no such thing. It feeds on small crustaceans and it comes out onto rocks at low tide. It has a skillful way of moving about. The blenny rides the crest of a wave and lets this wash it into a crevice. If the crevice is unsuitable the blenny joggles over the wet rock with scullion movements of its tail. When returning to the sea it waits for the run-off to carry it back. This and more Gatto learned, but he could not find out what use were the 'four eyes'.

Although *Anableps* was the first fish to be called four-eyed the only one that truly deserves the name was brought up from deep water in the North Pacific only a few years ago. Given the name *Bathyschlops exilis*, it is a slender pike-like fish, 1½ ft long, living in the twilight zone of blue light, between 300 and 3,000 ft down. From its shape it is a hunter that catches other fishes by short swift spurts. It needs good eyesight and the large eye has a retina made up of millions of rods, the light-sensitive cells. This gives wide vision and also keen sight for detail. Each large eye has a small eye on its lower part which looks downwards. These have their own retina and probably give greater sensitivity, especially in judging distances. Behind the small eyes are two smaller eye-like organs that are no more than swellings on the cornea of the large eye. They lack a retina and probably do no more than bend the light rays into the large eye. Yet this is only a guess and we may have to wait a long time for an explanation why such an unusual fish exists with four eyes on each side of its head.

class	Pisces
order	Atheriniformes
family	Anablepidae
genus	<i>Anableps anableps</i>
& species	<i>others</i>

Anableps anableps, the freshwater four-eyed fish of central America (natural size)

Francolin

Francolins are birds very like partridges or quails, in which they are related. They are among the largest of the pheasant family, reaching 18 in. long and weighing up to 3½ lb. Compared with some of their relatives, most francolins have dull colours, but their plumage is beautifully patterned. In a few the male is brightly coloured, but as is usual in this family, the female is always somberly coloured. The quail, francolin has a squat, rounded body, small head and short tail. They have sharp spurs. Like those of some gamecocks, and some male francolins have two on each leg.

There are 40 species, 36 living in Africa and 5 in Asia. A few are widespread, such as the bush quail of West Africa and the black francolin, which ranges from Libya to Cyprus and once lived as far west as Spain. Francolins live in wooded or bush country, not in open plains or thick forests. In Asia they are found both on the plains and in the hills, including the lower slopes of the Himalayas, at heights 7 000 ft.

Difficult to find

Francolins are shy, secretive birds, keeping to long grass or undergrowth and rarely flying. When they do take off they fly low with whirring wings, like other members of the family. They generally live in small coveys of 5 or 6 birds, retiring at night to roost in trees. In years gone by francolins were highly regarded as gamebirds, so most accounts of them have been written from the point of view of the sportsman. They have been variously described as 'probably the best gamebird in Somaliland' or as offering 'great sport'. '50 brace may be bagged in a single day by a single sportsman'. Such a sportsman must have been very painstaking, because other reports show how difficult it was to find the birds and to flush them. They can be seen darting across open ground, but once they have found cover they are difficult to locate, a crowching motionless, blending in perfectly with their background. They have even been credited with being able to hide the best dogs by arranging their feathers to prevent their scent from spreading. This story is hard to believe but it certainly shows their impressive ability to hide.

One way of locating francolins is to listen for their noisy calls, which range from harsh creaks to tinkling chirrups. Cock francolins begin to call at dawn, as one starts up others nearby immediately join in. Calling continues intermittently all day and is heard especially after showers of rain. The calls, however, appear to have a ventriloquial quality and both hunters and bird watchers have reported wandering around in circles in fruitless endeavours to find a calling francolin.

Scratching a living

Francolins scratch for food on the ground like domestic chickens, scraping back leaf

litter and soil with their stout claws and pecking up the small animals, plants and so on that are uncovered. They will dig for bulbs buried 2 in. deep. Their favourite feeding grounds appear to be in clearings, where they can easily scratch at the surface. They feed mainly in the early morning and evening, but during the rainy season they feed all day, when food is especially abundant. Ants and termites are especially favoured, and francolins also eat snails, beetles and spiders, together with seeds, fruit and the tender green tips of plants.

Pairs keep to themselves

At the beginning of the breeding season the small coveys of francolins split into pairs, each of which sets up its own territory. Ownership of a territory is advertised by calling, sometimes with male and female calling in a duet. In South Africa Hartlaub's francolin nests on kopjes. These are piles of boulders about 50 ft high that are scattered about the flat plains. There is one pair of francolins to each kopje, which start to call from the topmost rock just before sunrise. As the sun climbs higher in the sky, the calls gradually die away.

The nest is little more than a scrape in the ground, sometimes lined with leaves. The usual clutch is 5–6 eggs in some species and up to a dozen in others. They are incubated by the female alone for about 20 days. The chicks leave the nest very soon and are looked after by both parents.

Danger from fire

It is very unlikely that only man hunts francolins worth hunting. All they have to protect them is their shyness and ability to hide in thick cover, and their reluctance to take flight again once flushed. Bush or forest fires are a particular menace to their safety. These are most common during the breeding season, taking a toll of the eggs and chicks, and by destroying the cover they rob francolins of their main protection.

Slender evidence

The first specimen of the Somali greewing francolin was collected by the British

explorer JH Speke in 1855, just a few years before he discovered the source of the River Nile at Lake Victoria. At the time, however, this specimen was thought to belong to another species. It was not given its proper place in the classification of francolins until some years later. Then Lort Phillips, an American collector, found a freshly-killed francolin. Its head was missing but the wings were intact with their feathers still in place. The colouring seemed unusual so he took it home with him and it failed to match up with any specimen in the museum collections. Accordingly Lort Phillips fitted out another expedition to the Wagar Mountains in what was then Somaliland to look for this francolin, which was eventually named after him.

This account is perhaps rather trivial and of no great interest but it does show how much times have changed. Lort Phillips lived in the heyday of the animal collector. It seems incredible now that men had the money and the leisure to make a special trip to Africa, no easy business in those days, to search for an animal whose existence was based on the remains of a predator's feast. It is not even as if the animals were of any particular scientific or popular interest.

class	Aves
order	Galliformes
family	Phasianidae
genus & species	<i>Francolinus francolinus</i> black francolin <i>F. hartlaubii</i> Hartlaub's francolin <i>F. lorti</i> Somali greewing francolin <i>Pternistis leucoscepus</i> yellow throated francolin others

Like their relatives the partridges and quails, francolins make first-class gamebirds; they live in open country and grow up to 3½ lb, ranking among the largest of the pheasant family. Most of them have a dull, brownish basic colour but some—like the yellow-throated francolin (opposite)—sport bright patches of colour on head and neck.



Arthur Christensen



J.S. Waples



Simon Trepo - Photo Net

Frigatebird

Frigatebirds or Man-of-war birds are the rogues of the seas. They are related to boobies, cormorants and darters, and although they feed on squalid and live by coasts, they can hardly be called seabirds. Frigatebirds have become almost as well adapted to an aerial way of life as the swifts. Their legs are so weak they can only walk with difficulty and need to leap from a tree or rock to become airborne. Their feet bear only the vestiges of web and their plumage is not very water-proof, so they are helpless on the water. They have, however, an enormous wingspan, over 7 ft in the larger species, and which to support a mere 3 or 4 lb body. They have a larger wingspan-weight ratio than albatrosses and consequently are masters of gliding and soaring in the slightest breeze.

The silhouette of an airborne frigatebird is unmistakable, with long, pointed wings, a 4 in. hooked bill and a deeply-forked tail. The plumage is mainly black, but with blue or green. Males have a red throat pouch.

Frigatebirds are found in the warm oceans, especially where flying fish are abundant but they sometimes stray farther north or south; in 1953 one was seen in the Hebrides.

Coastal homes

Unlike albatrosses and many other sea birds, frigatebirds do not leave their nesting colonies outside the breeding season to make long voyages over the oceans. They are occasionally seen 500 or more miles from land, but it can usually be assumed that if several frigatebirds are seen together, land cannot be far away. Their attachment to the breeding colony has been exploited in the islands of the Pacific Ocean, where frigatebirds are tamed and used like homing pigeons for carrying messages.

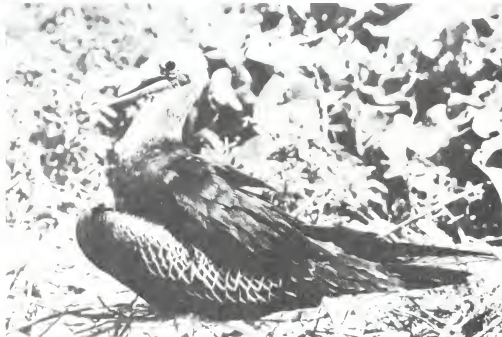
The Ancient Greeks considered the frigatebird to be the most aerial of birds. The swifts probably take pride of place, but the ability of frigatebirds to hover effortlessly or to soar for hours on end in air currents swirling up over cliffs is most impressive. Coupled with this, they can fly with the speed of a falcon and manoeuvre with incredible agility, using their forked tails as rudders.

Aerial highwaymen

For part of their time frigatebirds are pirates and robbers, stealing from other seabirds as they carry food back to their chicks. Boobies and gannets, and to a lesser extent noddies and tropic birds are harried by the swift-flying frigatebirds until, in desperation, they drop their food and escape. Immediately the frigatebirds swoop to catch the food before it hits the sea and sinks. The frigatebirds circle round the victim, pecking at its wings and tail and sometimes capsizing it. They are very persistent and the tormented bird can escape only by dropping its load or seeking refuge amongst trees. On



John Watman



John Watman



John Watman

Scenes in the life of the Man-o'-war bird

◁ *Top: Only child—a great frigatebird chick. It is cared for by both parents and depends on them for some 11 months before it learns all the aerobatic tricks of the frigatebird's trade and can fend for itself.*

Centre: Mature relation—an adult lesser frigatebird. Notice the enormous length of the wings compared with the size of the body.

Bottom: Gawkly adolescent—a youthful frigatebird sunning itself on the rocks, inclining its outspread wings to let the sun catch their undersurfaces.

▷ *A frigatebird squadron sweeps in to drink at 'Frigate Pool' on South Island, Aldabra, in the Indian Ocean. Tortoises have preceded them.*

▽ *Father's return—a male frigatebird touches down at his nest on Tower Island, Galapagos.*



CA Wright



Philippe Scott/Photo Disc

successful. However, frigatebirds will break off their attack if it seems they can't recognize the victim; the bird makes whether it is worth harassing or not, for several times if argument accepts of less.

Throughout the tropics it is rare to find a colony of seabirds that does not have its attendant frigatebirds parading offshore. The parent birds account to the west. There is a certain amount of food only during the breeding season, as the colonies are empty for the rest of the year and the birds spread over the ocean. For most of the year, frigatebirds must look their own

means that pairs breed at different times, so a frigatebird may find its nest has been occupied by another pair while it was away recovering from the previous breeding season.

An unusual feature of courtship is that the males are not aggressive at the start of breeding. As a result they can sit together and display communally, so providing a strong stimulus to passing females. When courting, a male ball opens his wings and inflates his throat pouch, which looks like a red balloon under his chin. During this period its colon becomes a brighter red.

swoop and carry them off if their parents neglect them for a moment.

Precision aerobatics

To snatch flying fish from the sea or food from a booby needs split-second timing and an incredible judgement of distances that must be the envy of pilots in display teams. The Cossack trick of picking a handkerchief from the ground with the teeth while riding a horse is child's play compared with the frigatebirds' skill. Bryan Nelson, who studied frigatebirds on the Galapagos,



Like a stack of globes at a sailplane club, frigatebirds wheel in a thermal (or using our current) over Tower Island in the sun-baked Galapagos Islands.

food, they swoop and snatch fish, squid, jellyfish or other planktonic animals that lie on or just below the surface. They also take a heavy toll of already bandied turtles as they struggle above the beaching and swim out to sea. Whole broods of turtles, numbering 100 or more, are periodically reaching the water's edge, as the frigatebirds swoop down and pick them up in their bills. The only hope of survival is for these turtles to hatch at night and disperse well out to sea before darkness brings the frigatebirds back.

A long adolescence

Frigatebirds breed on the coasts of oceanic islands, often among colonnaded beaches of other birds, from whom they do not only food but also eggs and chicks. The nests of sticks, twigs and bone are built in trees or bushes. So adept are frigatebirds at flying that they can dash from all trees with abandon.

The breeding period lasts much longer than that of any of their relatives, and like the wandering albatross, frigatebirds nest only every other year. They are not so faithful to their nest sites as other seabirds because they breed every other year if

when a female comes out the males shiver and comb their feathers.

A single white egg is laid and incubated by both parents in about 10-15 days. The egg hatches in 35 days and the chick is raised by both parents. In the great frigatebird of the Galapagos and others there follows a very long period of dependence on the parents. They spend 3 months on the nest and then another 8 months being fed by the parents while themselves learning to feed. This appears to be necessary because the food supply is erratic and because it takes a long time for the young to learn the swimming skills needed to catch their food. These gatherings of small chicks, swooping one another for food, are gradually learnt how to swim. Being taken to be turtles. So difficult as this technique, that many young frigatebirds die in starvation after their parents have supplied feeding them.

Their own worst enemies

As they live on small islands, frigatebirds have few enemies. The Galapagos short-eared owl, however, preys on the chicks there, but generally the chicks' worst enemies are other frigatebirds who will

records how he saw a frigatebird swoop at full speed towards a rock. As it hurtled past it bent its neck and wiped a thin smear of fish from the rock, making a faint click with its bill. On another occasion a frigatebird took a piece of fish from the sand. Examination showed that the surface of the sand had not been disturbed in the slightest. Similar control is needed for another trick of the frigatebirds. One will sometimes wait for the moment when a booby is about to feed its chick, then swoop down, knocking the boobies apart and taking the food from whichever booby has it in its bill. Moreover a frigatebird will play the same trick on others of its kind.

class	Aves
order	Pelecaniformes
family	Fregatidae
genus & species	<i>Fregata aquila</i> <i>Ascension Island frigatebird</i> <i>F. magnificens</i> <i>magnificent frigatebird</i> <i>F. minor</i> <i>great frigatebird</i>

Frilled lizard

One of the so-called dragons of Australia, the frilled lizard grows to about 3 ft long, with a slender body and long tail. It is pale brown, either uniformly coloured or with patches of yellow and darker brown. Its most conspicuous feature is the frill around the throat, like the ruff fashionable in Europe in the Middle Ages.

Apart from its size the only remarkable thing about this lizard is its frill. Normally this lies folded over the shoulders like a cape. It is a large area of skin supported by cartilaginous rods from the tongue bone which act like the ribs of an umbrella. In moments of excitement, muscles pulling on these raise the frill to 8 in. or more across, about as wide as the length of the head and body together.

It lives mainly in sandy semi-dry areas of northern and northeastern Australia.

Hindleg sprinter

The frilled lizard lives in rough-barked trees, coming to the ground after rain-storms, to feed. When disturbed on the ground it runs on its hindlegs with the frill laid back over the shoulders, tail raised, and the forelegs held close into the body. It may sprint for a considerable distance, or it may seek safety by climbing a tree. When brought to bay it turns, opens its mouth wide and extends its frill. The best description of what happens next is given by Harry Frauca in *The Book of Australian Wild Life*. It does not raise its tail, as it has often been reported to do, and as some other similar lizards are known to do, but keeps it flat on the ground. It sways from side to side and with its open mouth, coloured dark blue inside edged by pinkish yellow, surrounded by the greenish-yellow frill splashed with red, brown, white and black, it looks like a large flower among broad leaves. The colours of the lizard vary from one region to another. In Queensland the general colour is a sombre grey, in the Northern Territory it is pinkish, often with a black chest and throat. The colours of the mouth and frill also vary.

The open mouth and spread frill are a warning display. If the warning is ignored it passes to an aggressive display. The lizard steps boldly towards the intruder, keeping its mouth open and frill fully extended, and from the mouth comes a low hiss. The remarkable thing is that people who know very well the lizard can do nothing to harm them, tend nevertheless to be intimidated by all this show. Even a dog used to attacking larger lizards will retreat before it.

Meals of ants and eggs

The frilled lizard eats insects, including large quantities of ants, as well as spiders and small mammals. It is also said to be an egg thief. One of the many difficulties found in keeping this animal in captivity is that of getting enough of the right kind of food. In 1893, when the time it took to travel from Australia to Great Britain was much longer than it is today, the naturalist



Robert Oshaghi

W Saville Kent brought a frilled lizard to London, the first to reach Europe alive. When it was exhibited before an audience of learned gentlemen one eminent zoologist is said to have followed it, in his excitement, on hands and knees, to watch it careering round on its hind legs and displaying its frill. Unfortunately, there is no record of how Saville Kent managed to feed his pet, but, like many reptiles, the frilled lizard can probably go without food for months.

Universal umbrella trick

Neither does history record whether any of the learned gentlemen noticed a comparison between the lizard and a lady. At that time ladies carried parasols and it was not uncommon for a lady, confronted by a cow as she crossed a field, to frighten the cow away by suddenly opening her parasol in its face. Konrad Lorenz, in *King Solomon's Ring*, tells how his wife kept geese from devastating her newly-planted flower beds. She carried a large scarlet umbrella and thus she would suddenly unfold at the geese, with a jerk, causing the geese to take to the air with a thundering of wings. It is almost instinctive for a woman carrying an umbrella to use it in this way against a power-

△ DeFance: a cornered lizard unfolds its frill.

ful and persistent opponent. It is a matter of no small interest to find that this same effective defence should have been evolved by a lizard.

class	Reptilia
order	Squamata
suborder	Sauria
family	Agamidae
genus & species	<i>Chlamydosaurus kingii</i>



Frilled lizard (*Chlamydosaurus kingii*)

Frilled shark

This rare and little known shark, of which there is only one species, takes its back to prehistoric times 500 million years.

The modern known fossils of vertebrates were of fish-like animals without fins and with gill-like mouths. The first relics of modern fishes, though still very primitive, are first found in 400-million-year-old rocks. At a later date they began to separate into gill sharks and true or bony fishes—and the frilled shark is very like the fossils in their earliest stages.

The frilled shark is of long, a uniform brown and white, with a single dorsal fin set far back on its body. The outstanding feature that gives it its name is the six gills with their frilly margins on each side of the head—in pattern shared with the modern sharks. With few exceptions all modern sharks have five pairs of gills.

While most species of shark have been known for a long time, the frilled shark came to light in the 1930s. The first specimen was brought up from deep water by Japanese long-line fishermen, one of whom called it *ribuka* (silk shark) and others, *tokagizame* (lizard shark). The first name was probably based on the skin, almost silk-like fins, the second on its general appearance.

Another living fossil

The frilled shark has various primitive characters in addition to its six frilled gills. Its mouth is terminal, that is, at the front of the head. In modern sharks the mouth is on the underside, so the snout and upper jaw are changed. The putting snout forms a protrusion which makes for increased speed, and so helps to assume the frilled shark another speedy swimmer. The nostrils of the frilled shark are on the upper side of the head whereas in modern sharks they are on the underside. In modern sharks the tail has two lobes to the tail fin, a long upper and a smaller lower lobe. In the frilled shark there is no lower lobe and the tail as a whole trails horizontally instead of

curving upwards. All these things suggest a lethargic swimmer, and so do the frilled gills. In these the gills themselves, instead of being deep in the gill-cavity, are almost outside, virtually on the edge of the frill.

There is also a curtain of skin behind the back teeth. This probably acts as a valve so, whereas other sharks must keep swimming to breathe, the frilled shark—like bony fishes—can breathe by pumping water through the gills while stationary.

The teeth of the early sharks had many small pointed cusps, giving a comb-like effect. The living frilled shark's teeth have three pointed cusps with two smaller ones between, which is more than most modern sharks have. Other differences are that all the teeth are in use at once whereas in other sharks only those in front are functional. When these are broken, they are replaced by new teeth growing up and forward, on the conveyor-belt principle. The teeth of the frilled shark are in rows of fives, each row on its own plate, and there are 20-27 such rows in both upper and lower jaws.

The lateral line running down the flanks of true or bony fishes consists of a series of sense-organs, each opening by a pore, so that each sense-organ is embedded in the skin. In most living sharks the sense-organs are in a tube embedded in the skin. In the frilled shark the lateral line is an open groove with the sense-organs lying in it, as in the earliest known sharks.

Recent arrival

Frilled sharks live in deep water, in the Atlantic and on both sides of the Pacific, down to 1 800 ft. They are harmless to man in spite of the wicked gaping mouth. For one thing they live below the depths to which divers go, and they feed solely on deep-water octopuses and squids, according to the distinguished South African ichthyologist J.B. Smith, 'discoverer' of the coelacanth. He pointed out that the teeth all point backwards, like those of a snake. The gap of the mouth is wide, and the jaws are distensible, as in a snake, so Smith is not surprised the Japanese saw some resemblance to a reptile, even if they called it lizard rather than snake.

Smith presumes that once a frilled shark seizes its prey it has no chance of escape. The shark holds it, slowly working it back-

wards—pulling itself over its prey, so to speak. Such a feeding method is best suited to eating octopus and squid, rather than fishes coated with scales. Certainly the Japanese fishermen used squid for bait.

Because no frilled shark yet caught has had food in its stomach, or at best only a small quantity of semi-digested remains, Professor Smith suggests that, having eaten a large squid or octopus, the frilled shark lies on the bottom like a gorged python and ignores the bait.

One final clue to its feeding habits may be in its eyes. These can, according to Professor Smith, be protruded a little from their sockets and rotated upwards; only a bottom-living animal having to keep watch above for food or foes would need such an adaptation.

Prolonged motherhood

The female frilled shark lays eggs that hatch just before they reach the exterior. Each egg is oval, nearly 5 in. long, and one female may deliver up to 15 babies after a gestation of nearly 2 years.

Links in the chain

There are quite a number of deep-sea sharks but only one with six frilled gills. One other modern shark has six gills and a few have seven. Some of these sharks live in shallow seas, others in deep seas. The one species with six gills is *Hexanchus griseus*. It may be 17 ft long, and one of 26 ft in length was caught off Cornwall more than a century ago. Together with the several species of seven gill sharks, they are placed in a family on their own, the Hexanchidae. All have comb teeth but their mouths are on the underside of the head. They are primitive but are newcomers compared with the frilled shark, because the first fossils almost identical with them are found in rocks laid down a mere 100 million years ago.

class	Selachii
order	Pleuronotemata
family	Chlamydoselachidae
genus	
& species	<i>Chlamydoselachus anguineus</i>



Dull-coloured, eel-like, the rare frilled shark is 6½ ft long with its dorsal fin set far back on its body. It got its name from the six (sometimes five) gills with their frilly margins.

Fritillary

Fritillary butterflies owe their name to a genus of plants *Fritillaria* whose flowers have a dark and light chequered pattern. Certain butterflies of the family Nymphalidae have a similar pattern on their wings and were named 'fritillaries' by the early entomologists. Nearly all have the upperside of the wings reddish-yellow with black spots or chequers and the underside more variously patterned. The British usage of the name includes members of two subdivisions or 'tribes', the Argynni and the Melitaei; in America only the former are called fritillaries, the latter being known as 'checkerspots', and the distinction is a useful and logical one. Most of the argynnid or 'true' fritillaries have a pattern of metallic silvery markings on the underside of the hind wings, most beautifully developed in the Queen of



△ *Glanville fritillary larva Melitea cinxia*.

Spain fritillary. Metallic markings are never found in the melitaeids or checkerspots.

The larvae of both groups have rows of finely branched spines on their bodies and they pupate by hanging themselves up by the tail, as in all the butterflies of the large family Nymphalidae to which the fritillaries belong.

Localised colonies

Fritillaries are mainly woodland butterflies, the silver-washed, high brown and the two pearl-bordered fritillaries being especially characteristic of mixed woodland in which oak and birch predominate. The dark green fritillary flies on downs, moors, and open grassy country. The Queen of Spain fritillary is a very rare vagrant to the south of England; in continental Europe it is found both in woods and flowery meadows. Of the three British 'checkerspots' the marsh fritillary haunts marshes and damp meadows

and the Glanville lives in clark downs. All three tend to form small localised colonies, many of which have been exterminated in recent years; in Britain the Glanville fritillary is confined to the Isle of Wight.

Fritillaries frequent flowers but are seldom seen in gardens unless their haunts are or are surrounded by woods. They are highly characteristic of the temperate and cool zones of the Northern Hemisphere. Both groups are well represented in North America and in Europe where they extend



△▽ Gulf fritillary *Dione juno* emerges...



Queen of Spain fritillary. Another genus, *Eudonia* is represented by a number of species along the Andean mountain range in South America; they are intermediate in their characters between the true fritillaries and the checkerspots. There is only one truly tropical fritillary, *Argynnis hyperbaea* which is widespread in the Oriental Region and extends to New Guinea and eastern Australia.

No butterflies in winter

All the British fritillaries have two generations in the year, and all but one pass the winter as larvae; the exception is the high brown, which winters as an egg. The caterpillars of the silver washed and dark green fritillaries hatch from the eggs in August and immediately go into hibernation without feeding. They begin to feed in the spring on wild violets and appear in June or July, and the silver-blue emerges after 2 or 3 weeks. These two and the high brown (the three 'large' British fritillaries) fly from July to early August. The larvae of the two pearl-bordered fritillaries hibernates



△ ... and spreads its wings to harden and dry.

when nearly fully grown, pupate in the spring and the butterflies are on the wing in May and June, the small pearl-bordered rather later than the other. All three of the checkerspots (marsh, heath and Glanville) have a long larval life of 10-11 months, passing through their other stages quickly in the early or middle part of the summer. The larvae of the marsh fritillary hibernates communally in a web.

Different feeding habits

The larger species that fly after midsummer suck nectar from various flowers, thistles and bramble being among their favourites. The two pearl-bordered fritillaries are late spring butterflies; the blue woodland flower called hugh often commingles with them both in locality and season, and seems to be their chief source of food.

In their choice of larval food plants the two groups differ. The true fritillaries almost all feed on violets or closely related plants such as violas and pansies. The

across Asia to Japan. A few species are among the most northern of all butterflies. The Arctic fritillary *Boloria chariclea* is circumpolar in distribution and has been found at 8 degrees 42 minutes north latitude.

The few that occur south of the equator are nearly all mountain butterflies and are regarded as relict species which probably crossed the tropics in the cool conditions of the Ice Age. Three of these occur at altitudes of over 6 000 feet in Africa; they are members of the genus *Isona*, related to the



checkerspots on the other hand range widely in their food plants, but each species is usually confined to a particular plant species or genus, a habit that must be at any rate partly responsible for their occurring in localised colonies. Of the British species the Glanville fritillary feeds on certain species of plantain, the heath on cow-wheat and the marsh on devil's-bit scabious.

A question of madness

John Ray (1627-1705) was Britain's first true naturalist. In his *Historia Insectorum* he gives the species we know as the pearl-bordered fritillary the name April fritillary.

This seems quite inappropriate as the butterfly hardly ever appears before the beginning of May. A change of climate might have occurred, but the probable explanation is that Ray lived before the change in the calendar that took place in 1752. In that year 11 days were omitted in order to bring British practice into line with the Gregorian Calendar of continental Europe. This resulted in an 11-day shift of dates relative to the seasons; before it took place the pearl-bordered fritillary must regularly have appeared in Britain before the end of April.

The name of the Glanville fritillary commemorates a curious story. In the early part of the 18th century a well-to-do lady of this name was among the early butterfly collectors. Women who did such things then were regarded as somewhat eccentric, and when Lady Glanville died her will was disputed by some disappointed relatives on the ground that because she collected butterflies she must have been mad! The case went to court, but it is pleasant to record that her reputation for sanity was upheld and that the greedy relations incurred trouble and expense to no purpose.

class	Insecta
order	Lepidoptera
family	Nymphalidae

British fritillaries

Tribe Argynnidi

<i>Argynnis paphia</i>	silver-washed fritillary
<i>A. cydippe</i>	high brown fritillary
<i>A. aglaia</i>	dark green fritillary
<i>Issoria lathonia</i>	Queen of Spain fritillary
<i>Clossiana euphrosyne</i>	pearl-bordered fritillary
<i>C. selene</i>	small pearl-bordered fritillary

Tribe Melitacidi

<i>Melitaea athalia</i>	heath fritillary
<i>M. cinxia</i>	Glanville fritillary
<i>Euphydryas aurinia</i>	marsh fritillary

Left: High brown fritillary *Argynnis cydippe*.

Top: Mountain species *Melitaea didyma*.

Centre: Pearl-bordered fritillaries mating.

Bottom: Small pearl-bordered *Clossiana selene*.



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Frogmouth

Frogmouths are birds related to the nightjar, and are named for their wide mouths that open in a frog-like gape. There are 12 species, ranging in length from 9 to 21 in. Their plumage is soft and silky and is patterned with streaks and bars. They resemble owls in size, softness of plumage and general colouring. Frogmouths have two basic body colours: greyish and red-brown, being either one or the other, regardless of species. This is known as dichromatism.

Frogmouths live in the tropical forests and bush country of southeast Asia and in Australia. They are found from India to the Solomon Islands. The large tawny frogmouth, or mopoke, is found in most of Australia and in Tasmania. Recently one species has been found in Yunnan, southern China.

Silent night flier

Like their relatives the nightjars and owls, frogmouths are nocturnal, which has made study of their habits difficult. They are active mainly after dusk and before dawn, but their calls may be heard throughout the night. The call of the mopoke is a muffled 'oom-oom'. Frogmouths are seen singly or in pairs, and are nowhere abundant. They are fast fliers but are not as agile as the nightjars; but their flight is silent for their wing feathers are floppy, like those of owls.

Luring or hunting?

At one time the frogmouth's method of feeding was a matter of speculation, as no

one had actually watched them. Because they had such large mouths, it was suggested that they hawked insects, flying about after moths and beetles with their mouths agape, like living butterfly nets. This idea was supported by the rictal bristles around the mouth. In other insect-eating birds these are used to increase the area of the 'net'. Another, bizarre suggestion was that frogmouths sat on branches with their beaks open, revealing pink or yellow mouths. Insects were attracted under the impression that these were brightly-coloured flowers and therefore a source of nectar.

In fact, frogmouths employ neither of these methods. They catch their prey when it is motionless or only moving slowly. Some frogmouths wait on a perch and drop to the ground to catch an insect, while others fly around trees and bushes picking insects off leaves or branches. Insects are their main food, but they also catch centipedes, scorpions, snails, frogs and even small mammals and birds.

Loose, flimsy nests

Most of our knowledge of the frogmouths' breeding habits comes from studies in captivity. The nests are flimsy. Some frogmouths build a nest of twigs in a horizontal fork of a branch. The twigs are woven so loosely that the 2 or 3 eggs can often be seen from below. Other frogmouths make a pad of their own down, bound with spiders' webs and camouflaged with lichen. Some reports suggest that only the female incubates the eggs, or that the female incubates at night and the male by day, but the male was the only one to incubate in a pair of tawny frogmouths kept in a zoo. After about 30 days the chicks hatch, clad in white down. Both parents share in feeding them. Feathers start to appear after a week.

The tawny frogmouth is one of the birds that has been reported to carry young on its back. AH Chisholm recounts how a young frogmouth that had left its nest, but was unable to fly, was disturbed by a small box. One of its parents flew to the youngster, which climbed on its back and was carried away from danger. If a frogmouth is disturbed while on the nest its reaction is bluff rather than threat. It lowers its wings and raises the feathers around its head, so it looks much larger. At the same time it opens its mouth and 'glowers' at the intruder, a sight no doubt scaring enough to deter all but the boldest of enemies.

Out on a limb

If disturbed at night away from its nest, a frogmouth will fly away. During the day, however, it will 'freeze' on its perch on the limb of a tree with its bill pointed towards the sky. With its plumage greyish or reddish-brown with dark markings, the frogmouth looks for all the world like the broken stub of a branch. Indeed, this is very necessary for an animal that sleeps in the open during the day. So still are the frogmouths that at one zoo a notice reading 'This bird is alive' had to be put on their aviary to forestall repeated questions from the public, while the famous ornithologist Gould found that he could shoot one frogmouth without disturbing another perching beside it.

class	Aves
order	Caprimulgiformes
family	Podargidae
genera	<i>Batrachostomus</i> <i>Podargus</i>



◁ Bluff by tawny frogmouth *P. strigoides* △ Marbled frogmouth *P. ocellatus*



Fruit bat

There are 160 species of fruit bats; 60 of these are known as flying foxes (see p 795) and not all eat fruit, so their common name can be misleading. Scientifically, they are known as the Megachiroptera—literally 'big bats'—although some are small.

The Megachiroptera differ from the Microchiroptera (small or insect-eating bats) in a number of important ways. Their build is much the same as in the insect-eating bats: 4 fingers on each hand are greatly elongated and these, with the long forearm, form the main support for the web of skin, or wing membrane, used in flying. The fingers have the same number of bones as ours but each is very much longer. All bats have the first digit (thumb) free of the wing membrane and this has a claw which, with the claws of the hind feet, is used in climbing. Fruit bats differ in that the second finger ends in a claw, which is never found in insect-eating bats. Another difference is that fruit bats either have no tail, or only a stump. As a result they either have no tail membrane (or only a small one) whereas in the insect-eating bats the wing membrane, after joining the hindlegs, is continued to the tail, and this tail membrane is used as a pouch for the temporary storage of food.

Tongue-clicking bats

The head and face of a fruit bat is less grotesque than that of most insect-eating bats because there is no earlet, or tragus, in the ear, and because no fruit bat carries the folds of skin on the face, known as nose-leaves, used in echolocation. Fruit bats rely mainly on sight, but some of them use a simple form of echolocation. They listen for the echoes from clicks of the tongue instead of high-pitched squeaks.

There are no fruit bats in the New World, and in the Old World they are confined mainly to the tropics, especially where heavy rains give a profusion of trees; in Africa, India, southeast Asia and northern Australia. The short-eared fruit bat *Cyopterus sphinx*, the common bat of the Far East, weighs 1 oz but will eat 2 oz of ripe banana in 3 hours. It also frequently drinks nectar from trees whose blossoms open at night. The bat thrusts its head in to reach the nectar, its head becomes covered with pollen and when it visits the next flower it pollinates it. Its relative *C. blythi* in Ceylon roosts in the umbrella-like leaves of the talipot palm, 6–12 to a tree. Each hangs from the midrib of a frond by one foot with its wings wrapped around its body. Sometimes small companies will bite out the centres of the fruit clusters of the kint palm, leaving a hollow in which they roost.

Tree-roosting fruit bats in a Nigerian forest hang in heavy clusters from every branch. They often quit areas where fruit is not available, commencing between roosting and feeding areas.





Ten thousand calls an evening

Epauletted bats are common throughout the savannas and forests of West Africa. They range from pygmies only 3 in. long to giants with a wingspan of 25 ft. Their fur and wings are buff or brown, with small tufts of pure white at the base of each ear. The males have epaulettes of long silky white hairs tucked away in reversible pockets on their shoulders. These can be turned inside out to show the white epaulette, for what reason is not clear. All have disproportionately large heads with dog-like faces. They feed mainly on fruits and the nectar and petals of flowers. Sometimes the food is eaten where it is picked, but usually the bat stuffs its cheek pouches and flies to a convenient perch to eat. It does not swallow

the fruit but works a mouthful backwards and forwards from one cheek pouch to another, chewing it with its large sharp teeth until it has extracted all the juices. These it swallows, spitting out a pellet of fibres. Where epauletted bats have been feeding, the ground under the trees is carpeted with such pellets. At night, when feeding, they make a loud chewing noise. In addition the males are extremely vocal. Observations have been made on the noisy calling of Franquet's fruit bat *Epomops franqueti*. The males hang up in favourite trees, each in its territory, about 100 yd apart. From a distance of a mile their calling sounds rather like a flock of excited jackdaws. Close to, the individual males sound like cracked sheep-bells. One began calling at about

19 15 hours each evening and continued until 22 00 hours. His calls averaged 60 to the minute, which meant that in a single evening he gave nearly 10 000 calls. Then he was quiet until some time before dawn when he started up again and continued piping until first light.

The hammerheaded bat *Hypsignathus monstrosus* of West and Central Africa is 10½ in. long and has a wingspan of 3 ft. It has a large head with a swollen face, pendulous upper lip and a split lower lip. It is the noisiest of all bats and it has a bony voice-box which fills ½ of the body cavity, pushing the heart and lungs backwards and sideways. There are two hollow sacs beside the voice-box which act as resonators. Males and females occupy separate roosts and the



◁ Fruit bat skeleton shows the long, elongated skull—much more pointed than in other bats. Notice how the basic mammal's skeleton has been modified so that the five fingers are prolonged into the 'umbrella-ribs' supporting the bat's flying membrane.

△ Caught in the act: *Artibeus jamaicensis* in the latter stages of gorging itself on a ripe pawpaw in Barbados. This is not a true fruit bat but one of the microchiroptera that has taken to eating fruit. Each mouthful is chewed until the juice is squeezed out and swallowed, then a pellet of drained fibres is spat out. Unlike most animals, but in common with man and guinea pigs, fruit bats cannot make vitamin C which they get from fruit.

▷ That upside-down feeling: a resting fruit bat *Hypsignathus monstrosus squamius* at camera



young of both sexes are in a separate roost. From 18.15–23.00 hours the males call every half-second. The chorus is resumed for a while before dawn. This constant repetition of a loud, explosive 'kwok' could be territorial or to attract the females, except that the females seem to take no notice and the males crowd together in one tree to chorus.

The straw-coloured bat *Eidolon helvum* is the best known of the smaller fruit bats. It is found all over Africa south of the Sahara and is noted for its nomadic habits. Its wingspan is 2½ ft and it moves in groups of 1 000 or more from one ripening fruit crop to another. These groups are often attacked by local inhabitants, to be cooked and eaten. The straw-coloured bat chews fruit but swallows only the juice, the solid part being

spat out. The Arabian straw-coloured bat *E. sabaeum* attacks the date crops which have to be protected while ripening with bags made of split and woven palm leaves. This bat has been known to bite into trunks of trees to lap up sap in times of drought.

'Humming bird' bats

The pollen-eating or long-tongued bats include some of the smallest fruit bats. They are 2–2½ in. long with long muzzles, long tongues and small teeth. They hover in front of night-blooming flowers, clinging for a moment to insert their slender heads and long tongues to take nectar and pollen. They are believed to help in pollination but in this as in most of their natural history we

are largely in the dark. Of the 17 species one lives in West Africa, the rest live on South Pacific islands, from New Guinea eastwards.

Slightly larger are the tube-nosed bats, with 12 species in the area from Malaya to northern Australia. Their nostrils are at the ends of long tubes. When the bats call with a high whistling note the tubular nostrils move with a trembling motion. It is believed they are concerned with echolocation but proof of this is still needed.

class	Mammalia
order	Chiroptera
suborder	Megachiroptera
family	Pteropidae

Fruit fly

Fruit flies are very small insects that go almost unnoticed unless they have to be killed out of a drink, but they are one of the most important laboratory animals. Fruit flies are fruit flies, with (ish-shaped) halteres (modified vestigial wings) instead of a real pair of wings. Normal fruit flies are very much like houseflies in appearance, but only about 1/10 as long. Their bodies are ball-like, yellowish or brownish in colour, and their eyes are red. They have a slow waddling gait with their abdomen wagging down, looking as if they are having difficulty in keeping airborne.

Vinegar flies and wine flies

Many of the different kinds of fruit fly are so similar that careful examination of pupal features under a microscope is needed to tell them apart. About 2000 species have been found, half of which live on Hawaii. For some reason there has been a massive evolution of fruit flies on

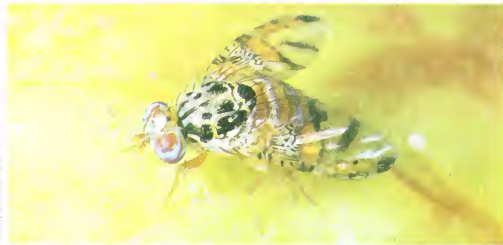
eggs are spindle-shaped with hair-like filaments at one end. The filaments may be used for breathing, as the eggs are often submerged in liquid with the filaments floating at the surface. The larvae have 11 segments each with a ring of hooked spines. At the rear is a telescopic organ bearing spiracles or breathing pores that can be raised above the liquid. The pupae breathe through feathery organs at the front end of the body.

With 2 000 or so species of fruit fly, many of which live in the same places and many having almost identical features, there must be some method by which species are prevented from interbreeding. Before mating, a male fruit fly courts the female, and she will only accept him if she is mature and of the same species. She recognises a male of the right species by sight, hearing or smell, or a combination of all three. The male fruit fly approaches the female, runs round her, licks her and finally mates. If they are of different species the female flies away, kicks the male or buzzes violently. While running around, the male vibrates one or both wings, and in some species it is the buzzing emitted by the wingbeats that is

attracted to light so they can easily be lured to one end of the container and transferred to another vessel without any being left behind or squashed. Their generation time is a fortnight; in other words the cycle of eggs, larvae, pupae and adults to the laying of the next generation of eggs takes a fortnight. This rapid breeding made them useful subjects for the study of population growth. If a pair of fruit flies are put into a milk bottle with food they start breeding and the population rises at an ever-increasing rate until a certain density is reached, when it slows down. Eventually the population levels off. The uneven growth rate, fast at first then slowing down, has been found in populations of many species from protists to man. The slowing-down has sometimes been found to be due to overcrowding. There is less food available for each individual and in fruit flies, as well as other animals, it has been found that females will not breed if they are constantly being disturbed.

Fruit flies have another and more important use. It was found that the cells of the salivary glands contained large chromosomes, and only two pairs of them. These are the string-like structures in the nucleus that carry the genetic information from one generation to another and which determine the hereditary characteristics of an individual. The large size of the fruit fly chromosomes made them very easy to study under the microscope. Moreover, as fruit flies bred very rapidly it was easy to study changes in the chromosomes, called mutations, and link them with corresponding changes in the bodies of the flies. One common change that occurs in fruit flies is for individuals to be hatched that have two pairs of wings instead of one pair of wings, and one pair of halteres. When body changes like this turn up, the chromosomes can be examined for changes in their structure. In this way a 'map' of the chromosomes can be made in which the pieces of genetical information, or genes, and the body character they control can be plotted. For instance, 100 genes have been found that control the eye shape.

These studies are helping us to understand the workings of heredity, and also the processes of evolution. Because of the rapid breeding rate it is possible to study the survival abilities of different forms of fruit flies, and so study the process of natural selection. Experiments have shown, for example, that light-coloured mutants do not survive as well in dry air as dark ones, but in wet air both types survive equally. Therefore, the two types live together in wet air, but if the humidity drops the dark fruit flies increase in number, replacing the light fruit flies.



Colourful cousin - the Mediterranean fruit fly *Ceratitis capitata* is from the family Tryptetidae.

Hawaii. Perhaps they have been free to evolve in the isolation of the mid-Pacific in the same way as Darwin's finches (p 615) evolved on the Galapagos Islands, only on a much larger scale. By contrast, there are 31 species in Britain, of which four are common. One arrived as recently as 1942, when it was found in London. It is now well established in the kitchens of restaurants and hospitals.

Fruit flies are also called vinegar flies or wine flies because they are attracted to weak solutions of acetic acid and alcohol, the principal ingredients of vinegar and wine respectively. They are often found in breweries, pickling plants, in bars and restaurants, where they settle on the rims of glasses and occasionally fall in. Fruit flies are also found in fruit stores where they feed on the juice, especially if it is fermenting. Other fruit flies feed on fungi or decaying plants or the sap flowing out of wounded plants.

Eggs submerged in liquid

The eggs, larvae and pupae of fruit flies live in the semi-liquid, often fermenting, substances that the adults feed on. The

important for identification of the species.

The buzzing is so faint that it has to be recorded by placing a fruit fly actually on the diaphragm of a microphone which is placed within several layers of soundproofing material. Even then it is necessary to make the recordings at night when all is quiet. All fruit flies of one species were found to buzz at the same frequency. The female is 'tuned in' to the frequency of her species, ignoring all others.

The female fruit fly lays batches of 15-20 white eggs each day, continuing until she has laid 100-900. When the larvae hatch, they burrow into the food material such as rotting fruit, staying there while they moult three times and emerging to pupate. The larvae of one species *Drosophila sigmaeoides* lives in the froth of the cuckoo-spit insect rather than in rotting fruit.

Bred by the million

Fruit flies have been extensively used as laboratory animals because they breed very rapidly. They can be kept in milk bottles or other convenient containers and fed rotten bananas or other fruit. They are

phylum	Arthropoda
class	Insecta
order	Diptera
family	Drosophilidae
genus	<i>Drosophila melanogaster</i>
& species	<i>D. sigmaeoides</i> <i>D. simulans</i> others



△ In the mood: as many fruit fly species are alike, identification courtship precedes mating.



△ All-round vision: close-up showing the many facets of a fruit fly's compound eye.

▽ Fruit flies mating. Their mutations and behaviour patterns are valuable to the scientist.



Fruit pigeon

The fruit pigeons are a large group of beautifully coloured pigeons which, although placed in one subfamily, are a common genus and may not be closely related to each other, there being five groups within the subfamily.

The green pigeons of Africa and southern Asia form a group of 20 species. They are pale yellow-green marked with yellow, orange, black or mauve. Another group is the imperial pigeons that range from Malaya through northern Australia and the Philippines to the islands of the South Pacific, while the smaller and more brightly coloured fruit doves are found mainly in the South Pacific islands. Closely related to these are the topknot or fork pigeons of Australia and the blue fruit pigeons of the islands of the Indian Ocean.

Brilliant plumage, good camouflage

Fruit pigeons live mainly in the tropical



New Zealand fruit pigeon *Hemiphysa novaeseelandica*, although colourful, is not conspicuous.

forests of southeast Asia, Australia and the East Indies. A few spread east across the Pacific and west to Africa and some extend south to New Zealand and Tasmania. Fruit pigeons are not as gregarious as other pigeons; some live in fairly large flocks, but others live in pairs. Because tropical forests are inaccessible, the habits of many fruit pigeons are not well known, and very little is known of the fruit doves in particular. Despite their brilliant plumage, these pigeons are very well camouflaged, blending with the sun-dappled leaves so that even flocks of them pass unnoticed. Oliver Austin recounts in *Birds of the World* how on shooting one fruit dove that he had finally managed to spot, the rest of the flock which he had not seen flew out of the tree.

The other fruit pigeons also live in flocks, often high in the tall trees of the forests. They are nomadic, continually moving about in search of fruit. The yellow-bellied fruit pigeon of the East Indies feeds mainly on wild figs and moves about as the figs ripen in different places. As a result it may

be common in one place one year but not the next. Some species perform regular migrations rather than irregular movements. The Torres Strait or nutmeg pigeon, one of the imperial pigeons, migrates in flocks across the Torres Strait, from New Guinea to northern Queensland, where it breeds on the islands around the coast. From the islands it flies to the mainland every day to feed.

Leaving the pips

Fruit pigeons climb nimbly in search of fruit, berries and seeds—the African green pigeon will even hang upside down like a tit. Apart from fruits and seeds they find in the trees, a few fruit pigeons eat termites, rice or millet.

A feature of all fruit pigeons is their ability to open their bills wide to swallow fruit whole. The imperial pigeons have an unusually wide gape because their jaws have elastic sockets, like those of snakes. As a result, they can swallow fruit and nutmegs larger than their heads. The species that eat mainly fruit have a gizzard lined with hard ridges and humps. Muscular action rubs the flesh of the fruit against the

gizzard wall so the soft flesh is torn off, the stones and pips passing straight through. The flesh is digested in the short, wide intestine. The fruit pigeons that eat seeds have a larger intestine, and a more muscular gizzard to crush them. Fig-eating fruit pigeons also have a muscular gizzard to crush the hundreds of small seeds in figs.

Openwork nests

Fruit pigeons make flimsy nests of twigs and rootlets. They are no more than a rough platform through which the eggs may be visible from below. The superb fruit pigeon builds a nest so flimsy that the sitting bird has to sit firm whenever the wind blows, holding the egg with her breast. The wedge-tailed fruit pigeon often nests near drongos (p. 670) to benefit from the ferocity with which these birds drive away enemies.

Incubation is carried out by the female, who is fed by the male. In the nutmeg pigeons the males make daily journeys from the islands to the mainland until the eggs hatch. Both parents feed the newly-hatched

young. All members of the pigeon family feed their young on pigeon's milk, a cheesy fluid, rich in protein and fats that is secreted from the lining of the crop. The adult fruit pigeon puts its head inside the mouth of the chick (the reverse of the usual procedure) and brings up the milk. After a few days the parents supplement the chicks' diet with fruit and seeds. The function of pigeon's milk seems to be to provide the young birds with a large amount of protein that they would not get from the adults' food. The fruit pigeons that eat mainly fruit lay one egg, whereas those that eat a lot of seeds lay two. This is probably because the fruit-eating pigeons cannot build up the reserves of protein necessary to lay two eggs or to feed two chicks on pigeon's milk.

Hunted for the pot

Throughout their range fruit pigeons are hunted for the pot and are said to be excellent eating. At one time it was thought that some might go the way of the recently extinct passenger pigeon that lived in North America in flocks of countless thousands. The early settlers in Australia used to slaughter nutmeg pigeons, and the flocks of 50–60 thousand were reduced to tens. The topknot pigeons were also reduced in numbers. These pigeons are now protected, although they are sometimes a nuisance when they attack fruit crops.

Brought to extinction

The island of Mauritius is famous for its extinct dodo. This is, however, only one of several animals that once lived on the island but succumbed to man's interference. The hatched pigeon once lived in countless numbers, but the last specimen was shot in 1826. This pigeon was also known as the pigeon hollandais, or Dutch pigeon, as its plumage of crimson, deep indigo and white recalled the Dutch flag with its horizontal stripes of red, white and blue.

The pigeon hollandais was killed off by the introduced Indian mynahs. Although so abundant the pigeon could not maintain its numbers against the depredations of the mynahs on its eggs and chicks. There are now only three specimens of the pigeon hollandais in existence in museums. Some may have been destroyed because it was not realised how valuable they were. In 1816 a French collection of 18,000 natural history specimens was bought by Edinburgh University. Not until 1855 was a specimen of the pigeon hollandais discovered in it.

Although the species is extinct, its name lives on. Another pigeon, living in Madagascar and the Seychelles, is called hollandais also because of its colouring.

class	Aves
order	Columbiformes
family	Columbidae
subfamily	Treroninae
genera	<i>Alcedroenas</i> blue fruit pigeons <i>Ducula</i> imperial pigeons <i>Lopholaimus</i> topknot pigeons <i>Ptilinopus</i> fruit doves <i>Treron</i> green pigeons

Fulmar

The fulmar's name is derived from 'foul-bird', based on its musky odour and its habit of spitting an evil-smelling oil at intruders. This habit is shared by many other members of the petrel family. The fulmar is a typical petrel: the body is short and stocky, 20 in. long, and the wings are long and narrow. In the north Atlantic the fulmar is silver-grey above and whitish below, but in the Arctic Ocean and North Pacific many fulmars are a sooty brown, light on the undersides.

In the Southern Ocean there is a close relative of the fulmar, the silver-grey fulmar. It is slightly smaller than the fulmar but very similar in colour and habits. It breeds around Antarctica and on some sub-Antarctic islands.

Soaring in the updraughts

In flight, fulmars look like small albatrosses, gliding on outstretched wings over the sea,

with only occasional wingbeats. Outside the breeding season fulmars stay away from land, quartering the sea in search of food. In spring they return to colonies on cliffs where they can be seen soaring in the updraughts, using their laminated tails as rudders. From a distance they can be mistaken for gulls, but their rapid wingbeats contrast with a gull's more leisurely flapping.

Over the last 100 years the fulmar has become a familiar sight in Britain. Up to 1878 the only known colony was on St Kilda, then in that year a dozen pairs were found breeding on the Kame, a 1,200-ft cliff on the Shetland island of Foula. Since then fulmars have spread around the British Isles as far as the south coast, and the new colonies are increasing in numbers. On Foula, for instance, the numbers rose to about 1,000 pairs by 1966 and they now breed inland, on rocky faces and in abandoned crofter's cottages and stone walls.

The increase has not been restricted to Britain. There have been remarkable increases in fulmar populations in Iceland and the Faeroes, starting in the former about 1710, and in the Faeroes about 1810. In all three places the increase seems to

have started from a few restricted foci, and new colonies have sprung from these in a progressive spread around the coasts.

The reason for the rapid increase in fulmars is not on the continent, but in the North Atlantic. It is due to the 1900 whaling activities. Then, the opening up of fishing grounds around Iceland, the Faeroes and the British Isles, gave unskilled fulmars with an obvious bubble-scaping of food. Whiskies, a whole new being cut up for its blubber. Fulmars got on in their thousands to feed on the guts and blubber and flesh. Now days they gather to feed on fish offal thrown over from codlers.

Surface feeders

Fulmars feed on the surface of the water, clipping their heads in or occasionally breaching like ducks. They mainly feed on squid, fish such as sandeels and young herrings and crustaceans but will also take jellyfish, comb jellies and other animals that live at the surface of the sea. The feeding on man-made supplies of food is probably a development of the fulmars' habit of feeding on dead seals, walrus and whales in the Arctic or on the carcasses of birds.



Fulmars on the rocks: nesting on cliffs gives them protection against many would-be predators



Winter courtship

The breeding colonies are visited in winter; the fulmars court from December to February onwards. Pairs of fulmars sit together on their nest sites cackling rather like domestic chickens. At the same time they nibble the plumage of their partner's head and fence with their bills. The single white egg is laid either on bare rock or in a slight depression in the soil made by the female. Nest sites are on small rocky ledges or crevices in cliffs or, where the fulmars are not disturbed, on flat ground, especially in abandoned buildings or by stone walls. In the British Isles it is rare to find fulmar nests far from cliff tops, but in Spitzbergen they have been found nesting 20 miles inland.

In the British Isles most of the eggs are laid in late May, but nearly a month later in the Arctic. Just before laying the fulmars leave the nest site for about a fortnight and disappear out to sea. It is thought that this pre-laying exodus or honeymoon, as it is variously called, enables the birds to put on weight. This is necessary, for egg laying takes a fair proportion of the females' food reserves, while the male has to fast for a week while he takes the first stint of incubation.

The chicks hatch after 40–50 days' incubation. At first they are covered with a white, fluffy down. They spend 7–8 weeks at the nest site before flying. Both adults

feed the chick. As the chick spits oil at everything that comes near it, the parent has to alight near the nest and cackle until the chick recognises it and sets up a regular monotonous call with which it solicits food. The adult fulmar then regurgitates half-digested food which the chick takes from its bill.

Cliff-hanging for safety

Fulmars are preyed on by bald eagles, gulls and skuas, which take adults, chicks and abandoned eggs. To some extent, at least, the fulmar's ability to spit oil seems to be an effective deterrent against their enemies. The chicks can spit several times in succession, each jet travelling 3 or 4 ft. The aim is not always very good, but is sufficient to hit any intruder at the entrance to a nest crevice.

Nesting on cliffs is undoubtedly a protection against many enemies. Mammals such as Arctic foxes are completely deterred. Flesh-eating birds can get to the cliff ledges, but if these are narrow they will have difficulty in landing to catch their prey. In the North Atlantic, however, man has made a habit of collecting cliff-nesting birds and their eggs for food. In parts of Shetland, for instance, each man had a section of cliff which he alone could harvest. On St Kilda, until its human occupants were evacuated in 1930, the community was the only one in the British Isles to rely mainly

on birds' flesh for protein. The St Kildans worked the cliffs in teams for fulmars and the catch was divided between the men in each team. Their feats of rock climbing were prodigious, as were those of the islanders of Shetland, Faeroe, Iceland and Greenland. In the latter two countries, large numbers of fulmars were taken for their flesh, oil and leathers, until several people had contracted psittacosis or parrot-virus and in 1940 it was shown that fulmars carried the disease.

Oily deterrent

The oil-spitting habit of the fulmar is never forgotten by anyone who has climbed around the cliffs in search of them or who has walked beside a dry stone wall and failed to retreat at the first 'f-chee' as a fulmar chick heralds its presence. On the islands around the Antarctic, the cliffs similarly abound with cape pigeons and snow petrels which also have the habit of spitting defiance and oil at intruders.

It is a foul liquid, often amber in colour, warm, sticky and smelling very strongly of cod-liver oil. The chicks generally spit farther, more accurately and more consistently than their parents. Their aim often goes wild but many a bird watcher has frantically rubbed oil from his face or camera lens. Cautious men have taken rash steps on cliffs to avoid fulmar nests and



G. Ruppen

many bird ringers have found their clothes unwearable except in strictest solitude. The oil is secreted from the stomach which is larger in petrels than in most other birds. The stomach wall has a large surface thrown into pleats and covered in glands that secrete the oil. Analysis has shown that the oil is chemically a wax, very like the wax from the head of sperm whales. It is rich in fats and Vitamin D, like cod-liver oil, and in Vitamin A.

While oil spitting is undoubtedly used in defence, it is likely that it has other functions. It has been suggested that it is used in preening and even for calming rough seas! The origin of oil secretion seems to be that petrels live mainly on crustaceans that are rich in oil and Vitamin A. Vitamin A and several other vitamins are toxic in large quantities, so the petrels may be using this device to get rid of excessive oil and vitamins. It is common for birds to gape and lunge at intruders at the nest, and the two habits may have become combined in the fulmar and its relatives.

△ Landing approach: three successive stages in a fulmar's flight altitude, with the wings being flexed to decrease the bird's forward speed and its 'undercarriage' being lowered at right, with wings spread again for a final halt.

▷ Suspicious glance from a fulmar, showing the distinctive tube-shaped nostril cover found in all petrels. This 'tubenose' arrangement may be to help the nasal gland to excrete salt, or an extension of the highly-developed sense of smell.



Eric Hoeking

class	Aves
order	Procellariiformes
family	Procellariidae
genus	<i>Fulmarus glacialis fulmar</i>
& species	<i>F. glacialis</i> silver-grey fulmar



Fur seal

The fur seal is probably known better to most people as a fur seal than as a marine mammal. Over the past 200 years or so, many thousands have been slaughtered by hunters and the animals have been brought to the verge of extinction. One-third live in the north of hemisphere and the species in the southern.

The northern fur seal is larger than its southern counterpart. Adult males grow to 7 ft long and weigh 600 lb, the females being only 5 ft long and up to 400 lb weight. There is considerable difference in size between the sexes is common among seals. The southern seals grow to just over 6 ft

and weigh up to 350 lb (males) and 1½ ft to just over 100 lb (females).

The fur seals belong to the family Otariidae, or eared seals. That is they have a small external ear, not found in the Phocidae or true seals. Other distinguishing features are the ability to turn the hindflippers forward and walk with the body raised from the ground, as well as having the body covered with a dense fur quite unlike the coarse hairs of the phocid seals. The foreflippers are large and mobile. The hindflippers have small nails used in grooming, the animal being able to reach its face and neck with the hindflipper.

Adult seals vary considerably in colour depending on whether they are wet or

dry; a wet female may look almost entirely silver, but dries a dark brown. The males show less of a change, looking black when wet and also drying to a dark brown. In both sexes the underside is paler. The flippers are hairless, dark brown, and leathery. Young animals of both sexes are more the colour of adult females and may easily be confused with them.

Seals have ticklish whiskers

Seals spend much of their time in water but they also haul out onto beaches to rest. It was noticed by people working among the southern fur seals that they are decidedly ticklish. The beaches are often crowded and anyone moving among the seals needs some form of protection. He



△ In the nursery, a fur seal toddler surveys its torpid playmates and elders.



△ An adult colony poses on the rocks.



usually carries a light bamboo pole to fend off angry seals, but it is useless to belabour them around the head or body. This only annoys them more whereas a gentle tickling of the whiskers will nearly always cause the seal to move aside. This sensitivity of the whiskers is made use of by the cows when they are disturbed by bulls on the breeding beaches. They snap at his whiskers, so driving him away. If he is particularly persistent she may even hang onto his whiskers or bite at his chest. Possibly these sensitive whiskers are used in feeding, as organs of touch, especially when the animal is feeding on the sea bottom, or in murky waters.

Strange food facts

The northern fur seal eats mostly fish, such as herring and pollack, but it also takes squid. It has been blamed by the canners

for taking Pacific salmon, but whether it harms the industry has yet to be proved. One fur seal made history when a new species of deepsea fish *Bathylagus callorhinus* was found in its stomach. This also showed that fur seals sometimes dive very deep to catch their food. The southern species seems to exist to a large extent on krill, a small crustacean particularly abundant in Antarctic waters which forms the staple diet of whales and penguins as well as seals.

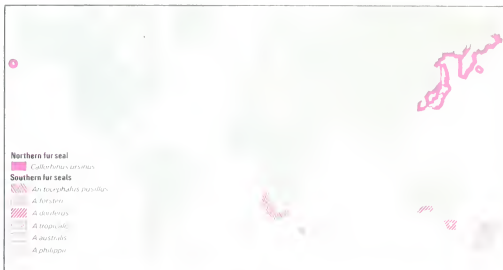
Competition for mates

The six species of southern fur seal differ slightly in the pattern of their breeding, but that of the Kerguelen fur seal, also found in large numbers at South Georgia, is fairly typical. In late September or early October the breeding season begins when the first bulls come ashore to take up territories, but

it is not until late October that the beaches begin to fill up. There is then a certain amount of territorial fighting as the bulls divide up the beach among themselves. Sometimes sudden fights take place with the bulls taking each other by the throat of the neck and shaking each other violently, occasionally causing quite serious-looking injuries. By early November the first cows arrive on the beaches and the bulls pounce on the females from straying. As the number of females on the beach increases each bull has a harder task trying to keep his group of cows or harem together. The young bulls (unable to gain a proper territory on the beach) occupy a piece of tidal strip or land well to the back of the beach. Some may even be able to hold a little territory of their own with perhaps one female. About 2 or 3 days



WEN TIEHILL



▽ Fur seal back-stroke: casual male waves a languid flipper.



Robert Burp



after coming ashore the cows give birth to their pups. In the southern fur seals the pups are $1\frac{1}{2}$ ft long and weigh about 10 lb at birth; those of the northern fur seal are $2\frac{1}{2}$ ft and 14 lb. In all species they are covered in black woolly hair which is moulted after 6 or 7 weeks. The pups are suckled for up to 3 months, but after the first few days the cow leaves her pup at intervals to go to sea and feed, returning every few days to suckle it. After about a week the cow mates with the bull and so the whole cycle is started again. The pattern is much the same for the northern fur seal except that the bulls come ashore in June. Female seals reach adult size in 3 years, males in 6–7 years. Fur seals probably live for 30 years but do not breed beyond 20 years of age.

from hookworm infection. Some pups die because of overcrowding on the beaches, being trampled to death, especially by the bulls during territorial disputes. Above all, man is probably the greatest enemy, although he is less so today than in the past.

The brink of extinction

The northern or Pribilof fur seals were discovered towards the end of the 18th century by the Russian explorer Pribilof. At that time the herds numbered about 25 million but hunting reduced this to about 200 000 in the early part of this century. In 1911 an agreement was made between Russia, America and Japan to limit the numbers of seals hunted at sea, and the herds have increased in size as a result of this protection. At the present time there is a care-

being fully explored at this time by furriers working at the Falkland Islands, South Shetlands and around Cape Horn, the last region being where the southern fur seal first appeared in the 1790s.

International seal conservation

The great slaughter that went on to both northern and southern hemispheres caused such devastation because the sealers were in the habit of killing all the seals they could lay their hands on, male, female or pups, regardless of the quality of the pelts. Twice in the 50 years after the discovery of the Pribilof herds the seals were almost exterminated, but each time they recovered only to be hunted down again. Eventually international agreement on the killing allowed the herds to be built up again, and during the last 50 years they have been the subject of an intensive scientific study and their management is very strictly controlled by the United States Government. Only the young males are taken and these are carefully divided from the colony into cubs and suitable animals selected for killing, the remainder being allowed to return to the beaches.

The skins are taken off, the blubber is removed and the pelts salted. They are then shipped to the processing plant where the longer, coarse guard hairs are removed leaving the fine underfur, which must be straightened and dyed. This process takes about 3 months. The pelts are graded and finally sent away to be auctioned and turned into coats and other articles of fashion.

The story of the southern seals is similar but here the sealers seemed to be particularly thorough and there was no government protection at first. The seals were almost totally exterminated and for a long period at the end of the 19th century the sealers found no fur seals and had to be content with oil from elephant seals and penguins. There appear to have been only a handful of animals left at the beginning of this century, and for about forty years only very small groups were seen. But during the last 10 years fur seals have been found in increasing numbers in the Antarctic, and their numbers have now increased quite dramatically. The distribution of southern fur seals at the present time extends from South America, the Falkland Islands, South Georgia, South Sandwich Islands, Australia, Tasmania, New Zealand, South Africa, Kerguelen, to most of the sub Antarctic islands.



◁ *Fur seal nursery off southern Australia*

△ *Look of appeal: a youngster on a snowy beach*

Beset by predators

The most natural enemy of seals is the killer whale, which kills mainly the younger animals but also takes adults. Occasionally seals are seen with a flipper missing, or with other serious injuries, almost certainly caused by killer whales. There is a record of a killer whale being found with the remains of 24 fur seals in its stomach. Young pups of the southern species may be molested by giant petrels but it is doubtful if the birds kill many. Parasites are often found in fur seals, one of the most important being the hookworm. This causes a high mortality among the northern fur seal pups, and in 1948 biologists found over 20 000 dead pups along $1\frac{1}{2}$ miles of beach in the Pribilof Islands, many of which had died

fully controlled industries taking about 60 000 animals each year, only the younger males in the 1–6 age group being taken as these not only make the best pelts but also the males are surplus to the breeding requirements of the herd as will be seen below.

The southern fur seals were discovered by Captain Cook at the time of his voyage in 1775. His reports of huge numbers of sea-beats soon caused a rush of sealers to the Antarctic, the Americans being particularly prominent, and around 1800 the herds were very heavily hunted. It was calculated by Weddell that at least 1 200 000 skins had been taken from South Georgia itself by 1822, and he noted that the seals were almost extinct at this date. Other colonies around the Antarctic were also

J. G. M. P.

class	Mammalia
order	Pinnipedia
family	Otariidae
genus	<i>Callorhinus ursinus</i> <i>nothura</i>
& species	<i>Arctoccephalus tropicalis</i>
	<i>Kerguelen</i>
	<i>others</i>

Gallinule

Gallinules are relatives of the coots and ducks, belonging to two genera: *Porphyrio*, the purple gallinule or swamp hen, and *Porphyryla*, the American gallinule. They are closely related to the moorhen, which is called the common gallinule in North America. Like coots, gallinules have frontal shields rising from the base of the bill. The plumage is a purple-black, with brown on the upper parts. The legs and toes are long and the feet are not webbed.

The purple gallinule is very widespread, ranging from southern Europe east and south to New Zealand and the Chatham Islands, and from open steppe to tropical rain forests. At one time it must have been a very flourishing species as until a short time ago it was found in isolated islands such as Mauritius and Reunion, as well as New Zealand and the Chatham Islands. It was once common in southern Europe, where, with the crested coot, it spread from Africa as a rather exotic addition to the fauna. The spolting of its habitat by human activities (mainly draining of wet lands) has now made it rare in Europe. It can still be found in Sicily, in cold parts of Spain such as the Coto Doñana and it may still linger on in southern France. The American gallinule ranges from the southern United States to southern Argentina, including the West Indies.

Damp habitat

Like most of the rail family, the gallinules live near water, among dense water plants surrounding lakes, pools, streams and marshes. Their long toes enable them to wade about on the leaves of lilies and other plants growing on the surface of the water. They are shy birds but can be seen wending their way through the tangled vegetation, flicking their tails at every step like coots or moorhens. Gallinules swim well and frequently climb trees where they may roost at night.

A wide-ranging diet

Gallinules feed on plants and animals. They eat flowers and water-plant leaves and will climb trees to eat berries such as mulberries, while water-plants and the bottom of shallow water are searched for molluscs, crustaceans and other small animals. The study of what gallinules eat is sometimes made easy by their habit of building feeding platforms of plants, which become littered with the remains of their meals. It is not known whether all gallinules build feeding platforms, but the purple gallinule of southern Spain and western Australia (where it is known as the western swamp hen) are known to do so. They often eat field-pods and aquatic insects; the remains of snail shells are often found on the feeding platforms and blood-stains show that they eat leeches. In southern Spain gallinules have been known to eat water snakes.

Nests with runways

Outside the breeding season gallinules live in flocks and in some parts of their range they are migratory. In the southern United States pairs start to form shortly after arrival in the spring, or even while en route. Each pair defends a territory about 200 ft along the bank of a stream or pool. Within this territory the birds feed separately, keeping in contact with one another by calling continually. They display to each other with their white tail feathers or by bowing with neck outstretched and wings held out from the body.

A couple of weeks after the start of courtship, the nest is built. This is made of plants piled upon each other, sometimes floating in deep water and sometimes built on the bed in shallow water. The plants are woven into the standing stems of water plants, both anchoring and camouflaging the nest.

bring food to the chicks, giving them mainly insects and other arthropods.

Slaughtered by pesticide

In 1949 a project was set up in the Wageningen district of Surinam to grow rice on a large scale using mechanised rather than traditional methods. A large area of swamp was cleared and intensive rice-growing started. Not surprisingly in this tropical region the crops attracted a large number of pests, from rats to snails. One of these pests was the gallinule. Although they feed on freshwater animals and so might be considered to have a useful controlling influence, they also feed on plants to some extent. They really became a nuisance, however, when they gathered in non-breeding flocks and broke the rice plants by attempting to perch on them. The solution to this



Gaudy coot relative, a purple gallinule moodily straddles its toes in the shallows.

The nest is about 10 in. across and as much as 20 in. high, with a cup at the top 2–3 in. deep. A peculiar feature is a runway 2–4 in. wide that leads at a steep angle up to the nest. Sometimes the runway, made of piled up plants, may go for 10 ft or so through the surrounding vegetation and is used by the parent gallinules for leaving the nest unobtrusively when danger threatens.

Up to 7 eggs are laid and incubated for about 22 days. Both parents sit on the eggs, taking turns of 3–4 hours each. When a gallinule arrives to take a spell on the nest it often brings a piece of a plant which it presents to its mate. This is not an uncommon feature of courtship in birds which the gallinule carries on into the nesting period. The chicks leave the nest shortly after hatching but will remain to roost, climbing up the runway, using their wings to help pull themselves up. Both parents

was to poison the flocks. Endrin, a pesticide, so powerful that it is banned in some countries, was sprayed from low-flying aircraft early in the morning as the gallinules sat on the rice. Such treatment is rather drastic and it is surprising that any pest of any kind survived. Probably the only pest-control programme to bear this is the use of dynamite to kill weaverbirds in Africa.

class	Aves
order	Gruiformes
family	Rallidae
genera & species	<i>Porphyrio porphyrio</i> purple gallinule <i>Porphyryla martinica</i> American gallinule others

Gall wasp

The familiar oak apples and marble galls on oak, and 'robin's pin-cushion' on wild roses are made by insect larvae. Some of these are made by the gall wasps, minute insects belonging to the order Hymenoptera and forming a superfamily, the Cynipoidea. They are closely related to the chalcid wasps (p. 408). Over 80% of cynipid wasps make their galls on oak and about 7% of them affect roses.

There are 228 species of cynipid wasps in Britain alone. Other gall-forming insects include certain saw-flies (also Hymenoptera), the gall flies and gall midges (Diptera) and some of the aphids (Hemiptera). In most cases, as in gall wasps, particular species confine their attentions to one species or genus of plant.

Food and shelter for the larvae

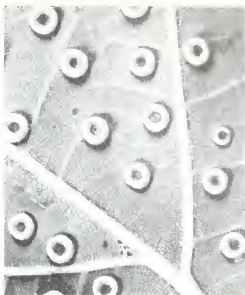
All gall wasps lay their eggs in the tissues of some particular part of the plant, a flower-bud, a leaf-bud, the blade of a leaf or even the root. No effect is seen until the minute larva hatches from the egg, but from this time on, the tissue of the plant surrounding the larva develops abnormally, usually swelling up and providing the insect with both shelter and food. It is believed that the plant tissues are stimulated to grow in this irregular way by some secretion given off by the larva. The swelling size, colour and shape of the gall depend on the species of wasp that laid the egg. In some cases a number of eggs are laid and the larvae grow up together enclosed in the same gall. The activities of the mature insects, as far as they are known, seem to be concerned almost solely with completing the complicated life cycles typical of gall wasps.

Types of gall

There are many different types of gall only a few of which can be described here.

Oak apple. When fully formed the oak apple is a round, spongy, fruit-like object, 1–2 in. diameter and coloured light brown or pink. If opened in June and July when mature it will be found to contain a number of larvae, usually about 30, each enclosed in a little chamber in the gall tissue. The oak apple represents a stage in the life history of the gall wasp *Biorhiza pallida*, whose life cycle will be described later.

Marble gall. Caused by the gall wasp *Andricus kollari*, this is the most familiar of all the oak galls and is often mis-named 'oak apple'. It is green when it reaches full growth—rather less than 1 in. diameter—in August and then turns brown and woody and remains on the twig after the leaves fall, when it is very conspicuous. It harbours only one larva of the gall wasp, whose exit hole can be seen in an old gall. Often there is more than one exit hole, and this means that the gall has harboured other parasites or 'inquilines'. Males of this gall wasp are quite unknown. In an attempt to find them I bushels of the galls were once collected and the wasps bred out, but among over 12,000 females that hatched not one male was found.



Common spangle gall. In July numbers of little round button-like objects can often be seen on the undersides of oak leaves, attached by a central stalk, so they look like tiny, very short-stemmed mushrooms. This is one of the two kinds of gall formed by *Neuroterus quercus-baccarum*. Each contains a single larva, and in September the stems break, and the galls fall to the ground where the insects inside them pass the winter. The wasps that hatch in April (females only) climb the trees again and give rise to currant galls, which look like bunches of red currants and in no way resemble the spangle galls, which the next generation of wasps will again produce. This alternation of generations is more fully described below.

Bedeguar gall. Also known as the moss gall or robin's pin-cushion this spectacular gall of wild rose bushes is almost as familiar as the marble gall. The part containing the larvae is surrounded by a tangled mass of branched fibres, green at first, turning to bright red in July and August. Inside are 50 or more cells, each containing a larva of the gall wasp *Diplolepis rosae*.

Unusual life history

In many gall wasps there is an alternation

of generations, already mentioned in connection with the spangle and currant galls. The rather similar life cycle of the oak apple gall wasp *Biorhiza pallida* shows this.

When the oak apple is mature, the larvae in it pupate, the wasps hatch in July and eat their way out. They include both males and females, the former being winged, the latter wingless. After mating, the females crawl down the trunk of the tree and enter the soil, making their way to the small fibrous roots, in which they lay their eggs. When the larvae hatch, galls develop on the roots, round, dark brown and of 1/2 in. diameter, usually unlike an oak apple. The wasps which emerge from these are all wingless females. They must find the tree trunk, crawl up it and seek the ends of the shoots, where they lay their eggs (without mating) in the terminal buds. When these hatch the larvae form a new generation of oak apples.

In the case of the spangle gall and currant gall wasp *Neuroterus quercus-baccarum* the female-only generation appears in April,



Stephen Dalton/IBRAK

having overwintered in the fallen spangle galls among dead leaves under the tree. These wasps lay unfertilised eggs which form the larvae, giving rise to the currant galls and causing a bi-sexual generation.

The life history of the marble gall wasp (*Andricus kollari*) is something of a mystery. We have mentioned that males of this gall wasp are quite unknown, but as long ago as 1882 an entomologist claimed that the species known as *Andricus curulans*, which makes galls on Turkey oak, is really the bi-sexual generation of *Andricus kollari*. This was confirmed in 1953.

Food always to hand

The sole food of the larva of any gall wasp is the substance of the gall which forms round it. The mature insects probably do little more than take a drink when needed.

Woodpeckers are known to peck open marble galls to get at the larva and currant galls are sometimes eaten by birds, which probably mistake them for fruit. By far the most serious enemies of gall wasps, however, are other insects which lay eggs in the gall. The larvae of some of these are parasites or predators on the 'legitimate' larva, the parasites slowly eating it alive, the predators

killing it and eating it outright. Others are inquilines, which feed on the substance of the gall, and so rob the primary inmate but do not otherwise harm it except sometimes to starve it enough to stunt its growth. The inquilines do not have it all their own way, for they too are preyed upon by predators and parasites, and these in their turn have parasites specially adapted to afflict them, known as hyperparasites. The inquilines are usually other species of gall wasp and the parasites chalcid wasps or ichneumonids.

If bedegnar galls are collected in late winter and kept in jars over damp sand, a remarkable assembly of tiny wasps will emerge. In one such experiment only a quarter of the insects were *Diplolepis rosae*, the makers of the gall, and of these (which numbered over 16,000) less than 1% were males. No alternation of generations is known in *D. rosae*, and it looks as if males are on the way to disappearing altogether.

Make your own ink

The very common and familiar marble gall has been a feature of the British countryside only since 1834, when it was found in a nursery garden in Devon. The gall, with its

△ Sliced-open gall shows a mature wasp and the chamber in which it has developed.

wasp *Andricus kollari*, had been brought into the country for use in the dyeing industry and for making ink, the tannic acid in the galls being the chemical agent involved. In fact, anyone can make ink from marble galls. All you have to do is to bruise 4 oz of galls with a hammer, put them in a quart of boiling water and leave for 24 hours. Then take 1½ oz of ferrous sulphate and dissolve rather less than an ounce of gum arabic in a little water. Filter the infusion of galls through cloth and add the other ingredients together with a few drops of carbolic acid. But perhaps it is better to buy a bottle of ink!

phylum	Arthropoda
class	Insecta
order	Hymenoptera
super-family	Cynipoidea

Gannet

Gannets are goose-sized relatives of the boobies (p264) that live in temperate regions of the world. The three kinds are considered by some ornithologists to be separate species and by others to be varieties of one species. There is little difference between the three.

Gannets are oceanic birds coming ashore only for the breeding season. They are strong fliers and cover vast distances, especially during the first year of life. Ringing has shown that New Zealand gannets migrate to Australian waters, setting out shortly after they have left the nest and crossing the intervening sea at an average of up to 240 miles a day.

The northern gannet migrates south to the Gulf of Mexico and the Canaries.

The gannet of the North Atlantic, known in parts of northern Britain as the solan goose, breeds on both sides of the ocean.

In America, there are half a dozen colonies around Newfoundland and the Gulf of St. Lawrence. It also breeds off Iceland, the Faeroes and the British Isles, with small colonies in Norway, Brittany and the Channel Islands. The largest colony is on the island of St. Kilda.

The Cape gannet breeds off South Africa and the Australian or Pacific gannet in the Bass Strait between Australia and Tasmania and North Island, New Zealand.

Gannet pugnacity

Gannets live by feeding on fish and squid, plunging in from a height or diving from the surface. Fish are caught as the birds surface rather than being impaled on the beaks of the gannets as they penetrate the water. The gannets do not dive very deep and will chase their prey, propelling themselves with both feet and wings.

The main food of the northern gannet is probably herring, mackerel, sardine and sand-eels. The first three are important commercially but it is very unlikely that the gannets affect the numbers caught by fishermen. In fact, the commercial catches of herring and other fish around the British Isles are going down, probably because of overfishing, yet the gannet population is steadily rising. So there are almost certainly no direct links between numbers of either the gannets or their prey. The Australian gannet feeds mainly on anchovies although it will take a variety of fish.

Gannet colonies are usually perched on small offshore islands or rocks, often no more than steep-sided towers rearing out of the sea, like Bass Rock on the Firth of Forth or Bird Rock in the Gulf of St. Lawrence. The nests are closely packed together, perhaps 2-2½ ft between each, so the cliff ledges and the tops of the rocks or islands are white with birds.

In February, when the rocks are still being



Eric M. Young



John Bourne

*Top: A gannet colony carpets a cliff-top.
Right: Like a diver on a high boat, a gannet goes through its take-off procedure.*

galled by winter gales, the male gannets engage in the colonies to re-establish ownership of last year's nest or if breeding for the first time they fly low over the colonies looking for abandoned nests. Fights are frequent as gannets defend their nests or seek to mate interlopers. They are not afraid to fight and often the case among birds that nest in dense colonies. The gannets grapple each other's bills or grab their opponent's head or neck, shaking, twisting and turning for up to 2 hours.



John Wainman

Furious fights in courtship

Bryan Nelson, who spent several years studying gannets on Bass Rock, has suggested that gannets originally nested on cliff ledges and the nesting on the flat spaces on top is relatively recent. This would explain several of the gannets' habits. When cliff-nesting birds light, one of them is sure to be pushed over the edge within a short time, automatically cutting short the fight. Gannets, on the other hand, grapple with their beaks and wrestle to and fro, neither bird appearing to be able to disengage. The fierceness of the gannets' behavior is continued in their courtship. The females are pecked during mating and whenever the males return to the nests after feeding.

The nests are large, compacted piles of seaweed, grass, earth and all sorts of rubbish including fish nets and tin cans. One list of materials included a gold watch and a set of false teeth. The pile is cemented by droppings and is useful as a jumping-off point for takeoff, as gannets have difficulty taking off from flat ground.

Feet make a hotwater bottle

The single egg, about 3 in. long, is a translucent pale blue at first, later turning to a

chalky white. As the egg is being laid, the gannet bends its tail under its body, directing the egg into the nest. This is probably another adaptation from their original cliff-nesting habit, where it is essential that the egg should not be allowed to roll away. Gannets have no brood patch where the egg is held to keep it warm. Instead the egg is held between the webbed feet. The gannet holds the egg lengthwise under its body and wraps a web around each side of the egg, overlapping underneath. Both parents in-

culcate, working in shifts of 1-2 days apiece.

Incubation lasts about 34 days. The chick hatches naked but quickly acquires a coat of down. At first it is brooded on top of the parents' feet then later sits by itself in the nest while the parents collect food for it. At Bass Rock the chicks are fed mainly on mackerel which they take by thrusting their heads into the parent's mouth.

When they have fledged at the age of 2 months the young gannets are abandoned by their parents and left to fend for themselves. They leap out of their nests and if they are lucky they immediately become airborne. Otherwise each has to struggle through the colony to the cliff edge, being attacked on the way and perhaps killed by the other gannets. Once airborne, the young gannets can fly quite well, but after they have settled on the sea they cannot resist. On leaving the nest they are very fat and they spend some time losing weight until they become airborne again and learn to catch their own food.

Violated sanctuary

On their inaccessible stacks and rocks gannets are immune to mammalian predat-

ors, except on St Kilda and a few other places where man has taken the sitting birds or their young. On Bird Rock, the building of a lighthouse gave access to the gannet colony which was nearly wiped out because the birds were killed for use as fish bait.

The main enemies of the colonies are herring gulls or black-backed gulls that steal eggs. Skuas chase the adults, forcing them to disgorge the food they are carrying back to their chicks.

△Open wide: mealtime for a gannet chick.

Dive-bombing technique

A flock of gannets feeding is a most spectacular sight. Like boobies, they plunge vertically into the sea, with wings half-closed, from a height of 100 ft or more. There is a continual rain of gannets diving down and disappearing with a spurt of spray. Later they emerge and climb again to rejoin their companions flying around above them before repeating the descent.

The impact of hitting the water at speeds of perhaps 100 mph must be severe, and if repeated time after time would inevitably lead to injury without special protection. Gannets and boobies have very much strengthened skulls that protect the brain, while an intricate system of air sacs in the head cushions the impact.

class	Aves
order	Pelecaniformes
family	Sulidae
genus	<i>Sula bassana</i> common gannet
& species	<i>S. capensis</i> cape gannet
	<i>S. serrator</i> Australian gannet

Gaper

Normally a bivalve mollusc lives within two shells or valves which can be closed tight or allowed to gape when the animal feeds—but a gaper is a bivalve mollusc which cannot close its shell. The two siphons of a gaper are connected throughout their length and although they may sometimes be withdrawn into the shell they are usually held fully extended. This causes the shell at the hinder end to gape widely. In Britain closely related species of *Mya* and *Lutraria* are given the name. Off the coasts of North America there are two species.

The three British species are the sand gaper, or old maid, with a shell nearly 8 in. long, the similar blunt gaper, with a narrower shell, and the small gaper. The sand gaper is also found on the coast of North America. The North American gaper of the Pacific shores from Alaska to San Diego is similar to but slightly smaller than the sand gaper.

Fountains on the shore

Found along the seashore or in shallow water down to 150 ft, the gaper burrows slowly into the mud, using the small foot at its lower end. It normally digs in vertically at 8–12 in. depth, with its long, fringed valve openings at its top end flush with the surface of the mud. A small depression in the mud shows where it lies buried.

When the tide is out, the North American gaper—which rejoices in the alternative names of summer clam, rubber-neck clam, high-neck clam, horse clam, otter-shell clam, and great Washington clam—gives more spectacular evidence of its presence. At fairly regular intervals, its siphons shoot a jet of water to a height of 2–3 ft. These jets are even more powerful when someone walks over the sand. Another water-squirting clam which looks and behaves like a gaper is the geoduck (pronounced go-ee-duck). Both geoduck and gaper are dug out for food, and so—occasionally—are the sand and blunt gapers in Britain.

How the siphon works

These water jets give a good clue to the gaper's methods of feeding and breathing. Water is drawn in through one siphon and passes across the gills, as explained under clam (see clam on page 449). Fine particles of food are extracted and oxygen is taken from the water for breathing. The water is then ejected through the other siphon, carrying with it waste products from the body. The way food is dealt with by the ciliated gills has been described for the cockle (p 470).

Losing its beard

The sexes are separate, the eggs and milt are shed into the sea through the exhalant siphon. The fertilised egg is developed into the usual veliger larva (see cockle, p 470). When the larva changes into the gaper, it is only $\frac{1}{8}$ in. across, and at first is quite different from the adult. The very

small gaper has a relatively large foot and short siphons, and it has a small blunt byssus threads (see clam, p 449) for fastening itself to a solid support. Gapers are known to live 17 years.

Food for walrus

Gapers are attacked by different enemies according to where they grow. Everywhere they are eaten by carnivorous sea-snails, such as whelks, which are collectively known as drills, from their habit of drilling holes

shells so rapidly that they cut off the end of the siphons or the tip of their own foot. Professors GF and Nettie MacGinitie, American marine biologists, report how they found small living animals on the shore which puzzled them. Even with the aid of zoologist colleagues they were unable to classify them. Finally, these 'animals' turned out to be pieces of clam siphon, still capable of muscular contraction and with cilia still beating, hours after they had been cut off by their former owners.



Heather Angell

in the shells with their radulae, or file-like tongues. On the shore, gapers are attacked by sea-birds and in some places toxes visit the shore at low-tide and dig out gapers. Fishes with stout jaws but crushing shellfish may take them, and in northern latitudes the blunt gaper forms the main food of the walrus.

Cutting off their feet

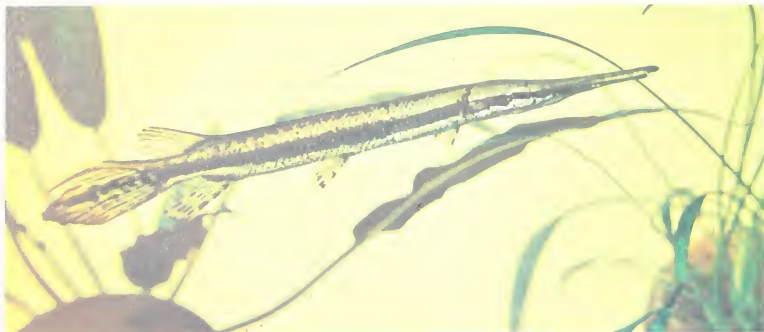
Although the double siphon of a gaper is protected by a tough brown skin with two horny valves at the tip, part of it, apparently, is often sacrificed, because these tips are commonly found in the stomachs of halibuts. Nevertheless, these lost portions can be regrown.

Another natural hazard of clams in general is that when violently disturbed they contract the muscles closing their shells so forcibly that a slight blow on the outside will cause their shells to break. A gull seizing one and flying up to 30 ft or so to drop it onto the beach is on to a good thing. The shell will then break as certainly as if dropped onto rock.

Some clams are their own enemies. When suddenly disturbed they may snap their

Common otter-shell. When relaxed and undisturbed, the gaper's siphon protrudes from its shell, taking in food and water and discharging body wastes and water. Some gapers are valuable. *Mya arenaria*, the sand gaper, is well-known to Americans as the soft-shelled clam, and forms the basis of East Coast clam-bakes and chowders.

phylum	Mollusca
class	Bivalvia
subclass	Lamellibranchia
order	Heterodonta
family	Lutrariidae
genus & species	<i>Lutraria lutraria</i> common otter-shell
family	Myidae
genetic & species	<i>Mya arenaria</i> sand gaper <i>M. binghami</i> small gaper <i>M. truncata</i> blunt gaper <i>Schizothaerus nuttallii</i> North American gaper otters



Credit: Wally Penner

Gar

These slender pike-like fishes are living fossils of a family that reached its peak in the Mesozoic period 70–220 million years ago. There are seven species living in the rivers and lakes of North and Central America.

The commonest is the longnose gar, or hillfish, which lives from the Great Lakes southwards. It is up to 5 ft long, its slim body covered with a tough armour of close-set diamond-shaped or rhombic enamelled (ganoid) scales which do not overlap in the usual manner of fish scales. The long snout is a beak; its jaws studded with small sharp teeth recall those of the gharial among crocodylians, the beak being twice as long as the rest of the head. The dorsal and anal fins are set far back on the body. The back is olive to silver, the underside white.

The shortnose gar, up to 2 ft long, lives mainly in the Great Lakes. The tropical gar of Mexico is said to reach 10 or even 12 ft, and the alligator gar which ranges from southern United States to Panama and Cuba is about the same size. Its snout is very like that of an alligator.

Indolent fishes

The gars live mainly in still waters, where they lie almost motionless among water plants, looking more like floating logs than fish. They move quietly and slowly to stalk passing prey, which is seized with a sudden sideways slash of the snout. Although apparently so lethargic, gars can move rapidly when necessary. Their food is mainly other fishes but little animal food is refused. Frogs, salamanders and worms are readily accepted and the young gar feeds largely on water insects. They soon take to catching fish, however, and a young 2 in. gar is on record as taking 16 young minnows in quick succession. It is easy to imagine from this the predatory nature of the gar and why fishermen hate them, and gars also take

but from their hooks. A gar can, with one snap of its jaws, seize a whole group of small fishes. With larger fish the prey must be gradually worked round in the mouth into a position from which it can be swallowed head first. All food takes 24 hours to digest, which is slow compared with most other freshwater fishes.

Eggs and babies stick to rocks

The males mature in 3–4 years, the females taking 6 years. Spawning is from March to May in shallow waters, each female being accompanied by 3 or 4 males. The average number of eggs laid per female is about 28 000 but may vary from 4 000 to 60 000 according to her size. The eggs are sticky and cling to rocks and water plants. In a few days they hatch and the baby fishes fix themselves to water plants by cement organs, adhesive discs at the end of the snout, and hang there until the yolk sac has been absorbed. After this they swim freely, feeding at first on mosquito larvae.

Rapid growth

In spite of its reputation for voracity, justified if by nothing else by its almost shark-like teeth, a gar has a low food consumption, feeds irregularly and has a slow rate of digestion. Yet it is one of the fastest growing of freshwater fishes. In its first year a young male gar grows on average just over 7 in. a day to reach 19½ in. by the end of the first season, the female reaching 22 in. in the same period. After that growth slows down to 1 in. a year but continues for 13–14 years in the females, which outlive the males. Because it moves about so little—even its feeding is leisurely—and because it has a high metabolic efficiency (that is, its body makes the fullest use of all its food), the energy supplied by the food goes into growing in size instead of being dissipated by moving about quickly and continuously.

Arrowheads and ploughs

In all probability it is because its scales are so closely set, forming such a rigid covering, that a gar must lead an inactive life. This

△ The dart-shaped body of short-nosed gar helps it merge with surrounding water plants.

though scaly armour of the gar has, however, proved very useful and been used by different peoples in different ways. The original inhabitants of the Caribbean islands are said to have used the skin, with its diamond-shaped, closely fitting scales, for breastplates. Some of the North American Indians separated the scales and used them for arrowheads. The early pioneers in what is now the United States found gar skin hard enough to cover the blades of their wooden ploughs.

class	Pisces
order	Ginglymodi
family	Lepisosteidae
genus & species	<i>Lepisosteus osseus</i> longnose gar <i>L. platystomus</i> shortnose gar <i>L. spatula</i> alligator gar <i>L. trisetochus</i> tropical gar



Garden snail

All too familiar to most gardeners, the garden snail is the second largest land snail in Britain. Its shell is up to $1\frac{1}{2}$ in. across, with $4\frac{1}{2}$ –5 whorls. Its tabby appearance is due to 5 dark brown spiral bands on a fawn, yellowish or buff background, the bands being broken by streaks of the ground colour making it look mottled. The shell is calcium carbonate (chalk) covered by a glaze of protein material which tends to wear off with age. The snail itself is dark grey. The head has two pairs of tentacles, the larger of which has eyes at the tips and can be pulled inside out by a muscle running up the inside. The smaller pair has other sense organs. When the snail withdraws, the opening into its shell is filled by a collar of soft tissue finely speckled with



Emerging from its shell, a snail spreads its two pairs of horns by turning them inside out, and raises its head to survey the scene before setting off.

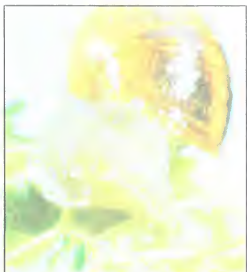
yellowish grey, and this has a hole, called the pneumostome, passing through it that periodically opens and closes. This lies a little to the animal's right side and leads into the 'lung', a cavity just beneath the shell used in breathing and also, by decreasing in volume, allowing the snail into its shell.

The garden snail *Helix aspersa* (aspersa for 'besprinkled') is often known as the common snail and 'garden snail' is commonly applied to *Cepaea hortensis*, a close relative of the banded snail (p 130). Confusion is avoided if one uses the proper scientific name.

Erratic shells are sometimes found in which the whorls twist in the reverse direction or are separated, making a corkscrew or cornucopia. Sometimes the colouring may be a more or less uniform yellow. Artificial monstrosities were once made for amusement. A snail would be removed carefully and placed in a shell of similar size but of another species. Eventually the snail would anchor itself in the shell and lay down new shell whorls of a different pattern and colour.

Rock-boring snails

Needing calcium for their shells, snails tend to flourish where soils and rocks are rich in it, and they are less fond of clay soils. Where calcium is scarce, the shell may be very thin, as in some populations in the Channel Isles. On the other hand, some areas are notable for the holes bored in limestone by these snails. These are about 1 in. across and may extend 3 or 4 in. upwards into the rock, worn by generations of snails. The garden snail is absent from northern Europe but occurs in the Netherlands, France, Spain, Portugal and around the Mediterranean and the Black Sea. It has also been introduced, or has found its way, to North and South America, Australia, southern Africa, Cuba, Mauritius and St Helena. In Britain it is widespread, except in the north of Scotland, and is most abundant in southern England, especially near the sea, and is found in gardens, hedges and quarries, under cliffs and banks and in old walls, particularly if ivy-covered.



Multi-purpose slimes

A snail moves by waves of muscular activity passing forwards along the sole of the foot. Generally 7 at a time can be seen as it moves over a sheet of glass. It gives out slime from just behind the head to make its slime track. This is not a continuous smear, but a series of patches where the foot has touched the ground. Slime of other kinds is given out from other parts of the body, including a bright yellow slime discharged when the snail is irritated. Slime, secreted by the collar, dries to form one of a series of membranes, sealing the opening of the shell when the snail is withdrawn, or it may be used to seal the opening against a flat surface.

Snails spend much of their lives drawn inside the shell during dry spells and in winter. Preparation for hibernation may begin as early as September, the snails congregating among the roots of shrubs or in old walls or burying themselves several inches in the earth, the mouth of the shell then being sealed. Young snails may spend a shorter time hibernating or may awaken temporarily on mild days in winter, but adults seldom stir until the following April.

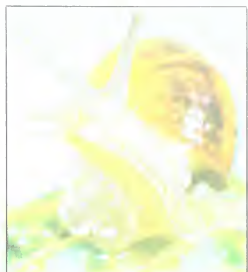
The moist surface of a snail, unlike our own skin, allows water to pass inwards or

onwards. Evaporation and the production of slime can lead to excessive loss of water but these are greatly reduced when the snail withdraws into its shell, as it does during dry periods. Its rate of living also slows down and months or years can be endured without re-awakening. There are records of snails remaining inactive for as long as 4 years and the Rev W Bingley wrote in 1805 of snails re-awakening after they had been more than 15 years in somebody's collection.

Under normal conditions this sleep may be ended by the return of wet weather, with a dramatic reappearance of active snails. Any deficiency in body water is then made up by absorption through the skin. Consequently, the amount of water in a snail's body is forever fluctuating, and the volume and concentration of the blood varies more particularly.

Home after a meal

Inside the mouth is a hard, curved plate, 2–3 mm across, called the jaw, and below

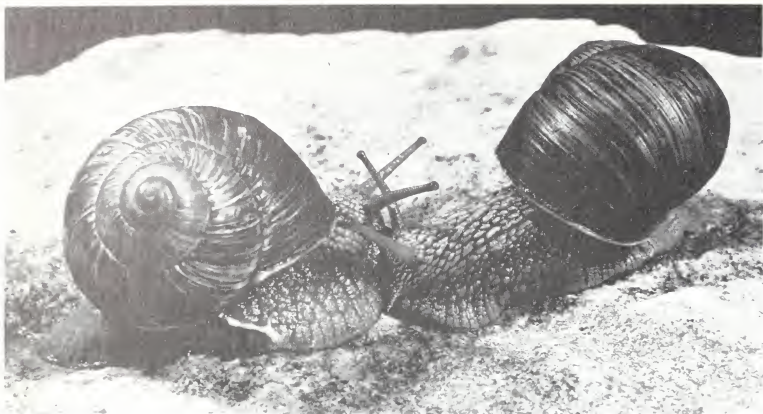


this is the file-like radula or tongue with 15 000 file-like horny teeth arranged in rows (see abalone p 6).

Garden snails, generally less of a pest in gardens than slugs, eat the leaves of many plants including lettuce, hops, primrose, nasturtium, aletai and, more remarkably, nettle and holly. They are fond of fruit and they may eat dead slugs and earthworms. Spindle and yew are said to be poisonous to them, and one may sometimes find large numbers of empty shells under yew trees. Snails will also eat paper. They have a well-developed homing instinct and regularly return from their foraging expeditions to the same roosting place, which is often communal. Gardeners who fix to get rid of snails by throwing them over a fence should know they will return, even climbing the fence to do so.

Uneven life history

Each snail has both male and female organs, being hermaphrodite. Mating, which may last half a day, takes place throughout spring and summer. Two snails, after mutual fondling, plunge their 'love darts' into each other. They are small chalky darts 1/4 in long (see banded snail, p 130), slightly curved and with four longitudinal blades, ejected



James Cary

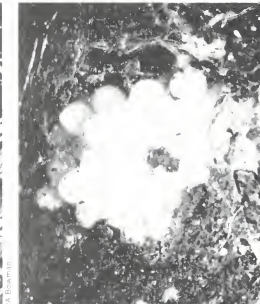
from special muscular sacs. Then follows an exchange of sperm contained in long packets called spermatophores. The eggs, 10–100 or so, are laid soon after in holes in the soil and covered over. They are slightly oval, 4 in. long, with tough, whitish coverings. They hatch in 2–4 weeks.

Although eggs are laid soon after pairing, the sperm can survive for a long while after being exchanged so eggs can be laid months later without further mating. In another species this interval has been known to extend as long as 4 years.

The young snails hatch with a glossy, unbanded shell of about 1½ whorls and grow to a third or half of the final size by the time they are ready to hibernate. Growth, like their lives so influenced by the weather, is not even. It involves the periodic rapid addition of shell around the aperture, sometimes as much as 1 in. in 2 weeks. The outer protein layer is produced first. Individuals have been known to live 5–10 years, but 2 years is more usual.

A neglected delicacy

Enemies are rats, moles, hedgehogs, field voles, rabbits, ducks, geese, domestic fowls, thrushes, blackbirds, glowworms, certain beetles and flies—and man. In Britain winkles (sea snails) and oysters are eaten with relish, and sometimes the Roman or edible snail. But although Lind snails of various kinds are eaten on the European Continent, few people in Britain can be persuaded to eat the garden snail. This was not always so, and in the 19th century 'wall fish', as garden snails were called, were on sale in markets at Bath, Bristol, Swindon, Covent Garden in London, and probably elsewhere. The glassmen of Newcastle cupped a least of them one once a year until at least 1880. An excellent imitation cream could be made from milk plus the slime;



Above and top: Garden snails mating. Although snails are hermaphrodite, they reproduce by exchanging the products of their gonads after stabbing each other with their 'love darts'.

Snails lay clusters of whitish eggs in the soil soon after mating. These take 2–4 weeks to hatch, and the baby snails emerge complete with a glossy, unbanded shell.

Shells found in Wick Barrow, Stogursey, suggest that garden snails were eaten in the early Bronze Age, about 1800 BC, and they seem to have been used in Roman-British times in the west of England. The Romans cultivated snails in 'cochlearia', the first of which were set up about 50 BC by Fulvius Plautius at Larquimm. This was recorded by Pliny the Elder who also recommended snails (but not *aspersa*) for coughs and stomach aches (to be taken in odd numbers). Snails and slugs have been used to treat a variety of ailments, notably pulmonary tuberculosis, coughs and colds. In Yorkshire, at one time, they provided a greenish salve for corns, and in the 1880s, plasters, sold at a penny each in London,

were made from papers over which garden snails had crawled.

Two additional uses for the garden snail were recorded by Martin Lister in 1678. He noted that the fluid obtained by pricking snails was used in bleaching wax for artistic purposes and also for making a firm cement when mixed with the white of egg.

phylum	Mollusca
class	Gastropoda
order	Pulmonata
family	Helicidae
genus	
& species	<i>Helix aspersa</i>

Garter snake

Garter snakes are the commonest and most familiar snakes of the United States and Canada. They also occur in Mexico. They are found farther north than any other reptile in the Western Hemisphere, the common garter snake as far north as 67 degrees latitude, in the Yukon. Garter snakes are non-venomous, slender, marked with longitudinal stripes, commonly 2 ft, sometimes 3 ft long, the record being 4½ ft. The common garter snake may be black, brown or olive with three yellowish, orange or red stripes. The stripes may be vivid or dull. The belly is usually yellow or greenish. All-black individuals may occur. One species, known as the ribbon snake, has three golden-yellow stripes, and its scales are more markedly keeled than in other garter snakes. It lives in southeastern Canada and the United States east of the Mississippi, especially in marshy areas, and takes readily to water. Another subspecies, the western ribbon snake *Thamnophis sauritus proximus*, lives west of the Mississippi.

From sea level to the Rockies

Garter snakes live in a variety of habitats from sea level to high up in the Rockies. The mountain garter snake is the only reptile in the Rocky Mountain National Park. The Mexican garter snake is found up to 13 000 ft. They are, however, often restricted to the neighbourhood of streams and lakes in the western half of the United States but are found almost everywhere in the humid eastern half. The plains garter snake is found even in the suburbs of towns such as New York and Chicago, where they hibernate in cracks in the ground near the bases of buildings.

They are the last reptiles to go into winter quarters and the first to come out, as early as March, from a hibernaculum which may be as deep as 3 ft underground. A saying of one tribe of North American Indians is that the first clap of thunder brings them out of hibernation.

It is said there is one or another subspecies of garter snake in every state, and in places the species overlap. Where they do there is no competition. The different species tend to occupy slightly different habitats, one preferring damper ground than the other, for example, and usually they show slightly different food preferences. They also tend to breed at different times.

Early food is worms

Young garter snakes feed almost entirely on earthworms in their first year. After that, although worms are the chief item in their diet, they also eat frogs, toads and salamanders, sometimes fish and occasionally birds' eggs. Large garter snakes may eat mice.

Very large litters

Mating takes place near the winter quarters, soon after the snakes come out in late winter. The male has tiny barbels on his chin which



Don Babin - Photofest

he passes along the female's back as he prepares to mate with her. Once mating is over the snakes disperse to their summer ranges. The young are born alive in summer in litters of usually 50–60 but the number may vary from 12 to 78. The newly-born garter snake is 6 in. long. It grows a foot a year for the first 2–3 years, is mature at 2 years old, is ready to mate in its third spring and may live 12 years. There is, however, a very heavy death-rate during the first few months, due mainly to predators and deaths from starvation.

Killed in error

Their enemies are snake-eating snakes, hawks, owls, skunks and domestic cats. All black individuals, or those with indistinct stripes, are apt to be killed by people in mistake for poisonous snakes. They are also killed in large numbers on the roads

Garter snakes take readily to water; this wandering garter has hunted down a small speckled dace and is dragging it onto a stretch of floating algae before tucking in.

A garter snake's defence is to give out an obnoxious fluid from a pore on either side of the vent. It may bite but this has little effect on the human skin.

Some snakes lay eggs; others, such as garter snakes, bear their young alive. The first is called ovipary, the second is oovivipary, and in this the eggs remain inside the mother until they hatch. In both the eggs contain yolk for feeding the developing embryo but in ooviviparous snakes oxygen for breathing and moisture must be supplied by the maternal tissues, so the shells must be very thin, virtually no more than a transparent membrane in most cases. In garter snakes, as well as European adders, sea snakes and the Australian



Joe F. Blomson/ARPA

copperheads, a sort of placenta is formed to carry nourishment from mother to developing young. It is a very simple affair, nothing like as efficient as the placenta of mammals, but it is enough to supplement the yolk supply already in the egg.

The main advantages of ovovivipary are that there is no chance of the eggs drying up and the temperature remains fairly constant. The mother can choose basking areas with suitable temperatures. This is important in latitudes where summers are short and where even summer temperatures are not high. Add to this the advantages of having even a simple placenta and it is easy to see why garter snakes can live so far north. The disadvantages of ovovivipary are that the mother is encumbered, less agile and therefore handicapped in hunting and in dodging enemies. In most species this is minimized by the broods

△ Colourful version of the common garter, with three stripes of vivid yellow.

carried being small in numbers. It is the more remarkable, therefore, that garter snakes should commonly have 50–60, even 78 young in a brood.

class	Reptilia
order	Squamata
suborder	Serpentes
family	Colubridae
genus & species	<i>Thamnophis sirtalis</i> common garter snake <i>T. elegans mountain</i> garter snake <i>T. elegans vagrans</i> wandering garter snake <i>T. radix</i> plains garter snake <i>T. sauritus</i> ribbon snake, others



Gaur

The gaur is the largest species of wild cattle, usually standing $5\frac{1}{2}$ –6 ft, but one male shot in Burma stood 7 ft high with a girth of $8\frac{1}{2}$ ft. The average weight of males is just under 1 ton with females somewhat smaller. Both sexes are black, with legs whitish from the knees and hocks down. Young gaurs are brownish-orange until they reach maturity. The horns are semicircular, curving sideways and corrugated at the base. They grow to 25 in. Male gaurs are immensely muscular and usually have a dewlap.

Closely related to the gaur are the banteng and the kouprey. Both are smaller than the gaur. Gaurs are still common in many places and banteng are not rare, but the kouprey is scarce. The male bantengs are black in the southern parts of their range and tawny in the north. Females are khaki or tawny. The legs and rump are white. The kouprey is the same size as the banteng. Both sexes are grey, with white patches on shoulders and rump as well as the legs.

The gaur lives in India, Burma, Vietnam and Malaya, where it is called the seladang. Recently it has been found in Yunnan, in southern China. The banteng inhabits Burma and Vietnam, is not found in Malaya or Sumatra, but is found again in Java and Borneo. The kouprey is restricted to northern Cambodia and southern Laos.

Cows lead the herds

These huge wild cattle live in mountain forests in small herds that are basically associations of cows with their calves. In January and February a herd of gaur usually consists of 5 or 6 animals of which 1 or 2 will be bulls. Then, in April or May, bulls join the herds for the rut, swelling the numbers to 9 or 10, although individual bulls may move from herd to herd. In May or June, they leave to form small herds of bulls only, or to live singly.

Each herd has a home range in which it is usually to be found. The home range is not exclusive, and several herds may cover one area, wandering 2–5 miles in a day. Sometimes the small herds join together so 50 or more gaur may be seen feeding in one valley. While they are feeding, one member of the herd, usually a cow, may stand, with head raised, on a mound or anthill, presumably acting as a sentinel, giving a loud whistling snort if danger threatens. A cow will also lead the herd while it is on the move.

Both gaur and banteng have been domesticated. The domestic gaur, called the gayal or mithan, is sometimes said to be a separate species, formed by the crossing of wild gaur and common cattle. The gayal has shorter horns and a wider forehead than the gaur. It is kept only by the Nagas

▷ Heavyweights in the wild: Indian gaur cattle in a forest clearing.





Jane Burton/PhotoFest

and Mishmis of Assam who use it as a status symbol and for sacrifices, rather than for meat or milk. Banteng are domesticated on the islands of Java and Bali where they are the common domestic stock.

Fond of salt licks

Gaurs feed mainly on grass or occasionally bamboo shoots, but also eat leaves and nuts. They feed in the open, usually at night, returning to the forest to chew the cud during the day. Like many jungle animals, gaurs are very fond of visiting salt licks. These are specially provided by man as a lure when gaurs are needed for domestication.

Wild bull rings

During the rut the bulls move from herd to herd, each mating with many cows, and because the herd is continually changing the hierarchy of bulls is continually changing. The dominant bulls are the largest and they display at each other by standing broadside with head lowered, 10–20 ft from their rival. Then one begins to circle while the other stands still, except to remain broadside-on. This display may last 10–15 minutes, or even as much as an hour, until one bull is intimidated and moves away.

There is no strict breeding season but the peak of the rut is in March and April when the bulls have joined the cows. Gestation

takes 9 months, so most calves are born in December or January. The cows leave the herd to give birth, returning after about 4 days.

Mass attack

Tigers may kill gaur calves, but are no match for an adult. A bull gaur advances with head lowered and sweeping up and down, threatening to impale any potential enemy on its horns. Sometimes the whole herd will advance *en masse*, presenting a formidable array of horns.

The last great beast

In 1937, the director of Vincennes Zoo was travelling through Cambodia, when he came across the head of an odd-looking ox hanging as a trophy in the house of a vet, Monsieur Saavel. Thus the kouprey was first made known to western science and became the last large mammal to be found. It had probably been overlooked because it is rare and lives in country that is hardly penetrated by westerners. When it was first seen it was probably mistaken for banteng or for domestic cattle that had gone wild. Even now little is known about it. It has been suggested that koupreys are cross-breeds between banteng and gaur, Indian buffalo or zebu, the Oriental domestic cattle. Another suggestion is that they are the

△ A family of banteng, probably a smaller domesticated variety of the gaur.

descendants of the domestic stock of the ancient Khmer empire. Both its form and its behaviour, however, suggest that the kouprey is a true species. The shape of the horns differs from those of other cattle in Asia, being cylindrical in section, recurved in males and lyre-shaped in females. Old male kouprey fray their horns near the tips, apparently by rubbing them on tree-trunks or antbills. Fraying has not been recorded in other wild cattle, except the European bison.

It is very likely that the kouprey forms a link between the gaur and banteng on the one hand and domestic cattle and the aurochs, the now-extinct wild ancestor of European cattle, on the other (see p 398). As such it is of interest to scientists, but the population, estimated at only 1 000 in 1940, is probably nearly extinct because of the recent wars in its homeland.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus	<i>Bos gaurus</i> gaur
& species	<i>B. banteng</i> banteng
	<i>B. saaveli</i> kouprey



Sally Anne Thompson

Gazelle

Gazelles are slender antelopes, dainty and graceful in movement. The males have sweeping, lyre-shaped horns but the females have short spikes or no horns at all. There are 10 species of true gazelle, genus *Gazella*, in Asia and northern and eastern Africa. The best known are, the smallest of all, the Dorcas gazelle, of Algeria to Egypt and the Sudan, only 21 in. at the shoulder, and Grant's and Thomson's gazelles of East Africa. There used to be vast herds of the last two before they were slaughtered by hunters or driven from their homes by the spread of agriculture. All are fawn-coloured with a white rump and belly, and a dark band along the flanks. They have a white streak on either side of the face from eye to muzzle and usually a dark streak below this. Grant's gazelle, together with Soemmerring's and the red-necked gazelles, are the largest, 33–37 in. at the shoulder with a white wedge-shaped patch on the rump.

Three other species are also known as gazelles. These are the Tibetan, Przewalski's and the Mongolian gazelle, all

of the genus *Procapra*. They live on the grassy plains of Siberia, Mongolia, China and Tibet. They lack the glands on face and 'knees' that are features of the true gazelles.

Common or rare

Gazelles usually live in dry country, although some live on fertile plains. Most species are widespread and exist in large numbers. Speke's gazelle, with an inflatable swelling on its nose, is found only in the deserts of Somalia; and Loder's gazelle, a very pale species with narrow, spreading hooves, is restricted to the Ergs, the dune areas of the Sahara. The red gazelle is known from only four specimens, all bought at souks, or markets, in Algeria.

The goitred gazelle, named for the small cartilaginous swelling in the throats of the males, is also a desert animal, living from Arabia to Mongolia. Like many other desert animals it migrates in search of food. In Soviet Asia, around Lake Balkash, the herds come down from the mountains to escape from winter snows and in Kazakhstan they migrate south some 300 miles across the steppes in winter. In the summer they return to feed on fresh vegetation growing under the snow. During the summer a herd may range over a few square miles but in winter it may have to move over 100 square miles in search of food.

△ A couple of Thomson's gazelle, enjoying a quiet scratch on the high veld.

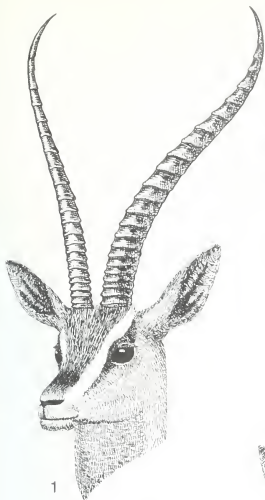
Water from absorbent shrubs

Gazelles eat grass when it is available, but in dry country they browse low-growing bushes and succulents. Many of them can go without drinking for long periods. Some Grant's gazelle were watched during a drought in East Africa when they ate mainly a certain dry shrub. Experiments showed that at night, when the relative humidity of the atmosphere was higher, this shrub absorbed water from the air, and so by eating at night the gazelles were able to get all the water they needed.

Territorial bucks

The goitred gazelle has a fixed breeding season. In September the bucks join the herds of does and begin to separate them into groups of 2–5, each protected by one buck. At the end of the rut in December the doe herds reassemble. Other species in more tropical areas have no fixed breeding season. In East Africa the strongest bucks of Thomson's gazelle establish territories of 20–60 ft diameter in open country which they defend against other bucks. When the herd, mainly of does, passes through the territory, the buck mounts several does. Any bucks travelling with the does are tolerated, but the rest form a separate herd





1



3



4



2



5

Gazelle portraits

Gazelle species differ only slightly, and one distinguishing feature is seen in the males—the difference between their sweeping byre-shaped horns. The females usually have stumpy spikes or no horns at all.

1. Grant's gazelle.
2. Mongolian gazelle.
3. Thomson's gazelle.
4. Goitred gazelle.
5. Dorcas gazelle.

Left: Siesta time—a male Grant's gazelle lies lazily in the afternoon heat near a female, while a herd of zebra grazes peacefully close by.

on the edges of the open country. In the dry season, the bucks leave their territories and join the main herd migrating to fresh pastures. When they return the territories have to be set up again, and it may not be the same animals that are successful in doing so.

When first born the young crouch hidden until they are strong enough to run. In a few days they can run fast enough to keep up with their mothers.

Wary but unafraid

In East Africa Thomson's gazelles are preyed upon by all four large predators: lions, cheetahs, leopards and cape hunting dogs, as well as hyaenas. Eagles also take the young. In Asia, wolves and tigers prey on gazelles. It is the bucks of the all male herds that suffer most. They live on the fringes of the bush where their enemies can be in wait.

Although built for running, gazelles do not use their speed to the full. They will run for 200–300 yd, then stop and look back at their enemies, or else they will run about, juking, rather than trying to put as much space between themselves and their enemies as possible. By contrast, they approach waterholes very carefully. The main herd halts some 200 yd from the water, then a few young bucks will rush up to the water's edge, quickly look round, then dash back to the herd. This is repeated two or three times, before the herd, convinced that there is no danger, comes down to drink.

Domesticated dorcas

Gazelles could be one of the greatest sources of animal protein in the dry parts of Africa and Asia, even though their numbers have been reduced by overhunting. In Kazakhstan, in Asia, for example, where they have been hard hit, there are 100,000 gazelles still alive. The domestication of gazelles along the lines being carried out with eland (p 701) would be no new undertaking. The dorcas gazelle was apparently domesticated by the Ancient Egyptians and the Romans. About 7,000 bc gazelle meat formed an important item in the diet of the people of Jericho, and in Egypt writings in a tomb dated 2,500 bc indicate that the occupant had owned 1135 head of gazelle. Later gazelles were kept by the Romans. Paintings in Pompeii show them in butchers' shops and they were also used for drawing children's chariots. Their skins were used for leather, their horns for knife handles and their ankle bones for dice.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus & species	<i>Gazella cuvieri</i> Thomson's gazelle <i>G. dorcas</i> dorcas gazelle <i>G. granti</i> Grant's gazelle <i>G. subgutturosa</i> goitred gazelle <i>Procapra gutturosa</i> Mongolian gazelle



Jane Burton/Photo Disc

Gecko

Geckos form a family of lizards noted for the large number of species, the structure of their feet, their voices, the differences in the shape of their tails, and for the ease with which some of them will live in houses. The smallest is $1\frac{1}{2}$ in. long; the largest—the tokay—may be 14 in. long.

Geckos are found in all warm countries: 41 species in Africa, 50 in Madagascar, about 50 in Australia, the same in the West Indies, with others in southern and southeast Asia, Indonesia, the Pacific islands and New Zealand, and South America. There are geckos in the desert

regions of Mexico and southern California. Several have been introduced into Florida from the Caribbean islands. Spain and Dalmatia, in southern Europe, have the same wall gecko as North Africa.

A liking for houses

The majority of geckos live in trees, some live among rocks, others live on the sandy ground of deserts. Tree geckos find in human habitations conditions similar to, or better than, those of their natural habitat: natural crevices in which to rest or take refuge and plenty of insects, especially at night when insects are attracted to lights. Because geckos can cling to walls or hang upside-down from ceilings they can take full

△ Pinhole sight: pupils shrunk to four tiny holes, to keep out excessive glare of the sun.

advantage of these common insect resting places, and so many of them are now known as house geckos.

Hooked to the ceiling

Most geckos can cling to smooth surfaces. Their toes may be broad or expanded at the tips with flaps of skin (lamellae) arranged transversely or fanwise. The undersides of the toes look like suction pads but apparently no suction is involved, nor are the undersides sticky. They have numerous microscopic hooks that catch in the slightest irregularities, even those in the surface of glass, and so a gecko can cling to all but

the most highly polished surfaces. The hooks are directed backwards and downwards and to disengage them the toe must be lifted upwards from the tip. As a result, a gecko running up a tree or a wall or along a ceiling must curl and uncurl its toes at each step with a speed faster than the eye can follow. Some of the hooks are so small the high power of a microscope is needed to see them, yet a single toe armed with numbers of these incredibly small hooks can support several times the weight of a gecko's body. In addition to the hooks, most species have the usual claw at the tip of the toe which also can be used in clinging. One species has microscopic hooks on the tip of the tail and these help in clinging.

Tails for all tastes

The tail is long and tapering, rounded or slightly flattened and fringed with scales, according to the species, or it may be flattened and leaf-like. A South American gecko has a swollen turnip-shaped tail. It has been named *Thecadactylus rapinaudus* (*rope* for turnip, *caudus* for tail). The flying gecko of southeast Asia has a leaf-like tail, a wide flap of skin along each flank, a narrow flap along each side of the head and flaps along the hind margins of the limbs. Should the gecko fall it spreads its limbs, the flaps spread and the reptile parachutes safely down.

Geckos can throw off their tails, like the more familiar lizards, and grow new ones. In some species 40% have re-grown tails. Sometimes the tail is incompletely thrown and hangs by a strip of skin. As a new tail grows the old one heals and a 2-tailed gecko results. Even 3-tailed geckos have been seen. Temperature is important in growing a new tail. It has been found that when the wall gecko of southern Europe and North Africa grows a new tail with the air temperature at 28 C/82 F it is short and covered with large overlapping scales. With the temperature around 35 C/95 F the new tail is long and is covered with small scales.

Permanent pair of spectacles

One difference between snakes and lizards is that the former have no eyelids. In most geckos the eyelids are permanently joined and there is a transparent window in the lower lid. The few geckos that are active by day have rounded pupils to the eyes. The rest are active by night and have vertical slit-pupils like cats. In some species the sides of the pupils are lobed or notched in four places, and when the pupils contract they leave four apertures, the size of pinholes each one of which will focus the image onto the retina.

Surprisingly small clutches

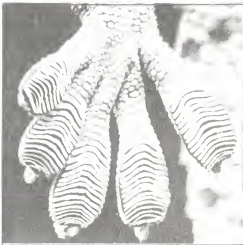
All geckos except for a few species in New Zealand, which bear live young, lay eggs

*Top: Close pursuit. As soon as the flies it is hunting, a diurnal gecko **Phelsuma vinsoni** pauses on a vertical tree-trunk, unaware of the apparent impossibility of its position.*

Right: Losing crampion. Geckos get a grip from tiny hooks in the flaps of skin on their feet. For right: After partial loss, regrowth and healing, the result is a three-tailed gecko.



ANTHONY BANISTER/TRAFFIC



© BIRCHMANN/TRAFFIC



JOHN VIGOR



© Geoffrey Bennett

with a tough white shell. Usually there are two in a clutch, sometimes only one. The eggs are laid under bark or under stones and take several months to hatch.

The ghostly gecko

Geckos eat only insects. They are harmless and wholly beneficial to man, yet among the people of Africa, South America, Malaysia and the aboriginals of Australia there are widespread beliefs that their bite makes them dangerous to handle. Possibly such beliefs spring from some of the more remarkable species, like the gecko that stalks insects as a cat does a mouse, even lashing its tail from side to side just before the final pounce. Then there are the web-footed

geckos living on the sand dunes of Southwest Africa. They not only use the webbed feet to run over loose sand but also to burrow. They scrape the sand away with the forefoot of one side and shovel it back with the hind-foot of the same side while balancing on the feet of the other side. Then they change over. They walk with the body raised high and the tail held up and arched.

One web-footed gecko has a delicate beauty. It is pinkish-brown with a lemon yellow stripe along its flank. Its eye has brilliant yellow lids, the iris is black, patterned with gold and coppery tints, while the edges of the vertical pupil are chalky white. Its skin is so transparent its spine and some of its internal organs can be seen clearly. G.K. Brain, writing in *African Wild*

*Not good enough: regrown tail of **Tarantola manritanica** shows that, despite camouflage, only desperate measures saved its life.*

Life, claims its two ear openings are almost in direct connection, so by looking into one earhole the light coming in through the other can be seen.

class	Reptilia
order	Squamata
suborder	Sauria
family	Gekkonidae
genus & species	<i>Gekko gekko</i> <i>others</i>

Genet

The genet looks like a cross between a tabby cat and a mongoose. With the civets and mongooses, genets make up the family Viverridae that lies between the weasel family (Mustelidae) and the cat family (Felidae). Three genets are well known and numerous; three are rare and little known.

The feline or small spotted genet is cat-like but more slender, elegant in build and graceful in movement. Up to 40 in. total length, of which nearly half is tail, its fur is soft and spotted with brown to black on a light ground colour. The head tapers to a pointed muzzle; the ears are large and the whiskers long. The tail is ringed with dark and light bands, and there is a crest of long black hairs along the back which is raised in moments of excitement. The legs are short, the paws are small and the toes have retractile claws.

The feline genet ranges over most of Africa apart from desert and semi-desert, and is also found in Spain and southern France, but the blotched or tigrine genet is more numerous throughout Africa. It is similar to the feline genet in form and habits but it has larger spots on a more yellowish ground and no crest along the back. The rusty-spotted genet is like the blotched genet except for its more reddish spots and it is found south of Tanzania. Some scientists believe it to be a colour variety of the blotched genet. The Abyssinian genet of the highlands of Ethiopia is small, has ash-coloured fur with longitudinal black stripes and is very rarely seen. The Victorian genet is like the feline genet but has richer markings. It lives in the Ituri Forest in the Congo and is known almost entirely from skins brought back by pygmy hunters of the Ituri. The first skin sent to London by Sir Harry Johnston in 1911 was obtained in the region of Lake Victoria, but the animal does not live there.

The water genet is known from only three skins. It is the size of a domestic cat, has a rich chestnut fur with white markings on the face and a black bushy tail. It was unknown, except to the local people, until 1919.

Ghostly markings have a purpose

A notable feature of genets is their white face markings. They bring to mind the white facial markings on badgers and foxes, two other nocturnal animals, and the markings of the genet may provide a clue to the use of these. When a genet is seen on a dark night, these white marks on the face stand out in the same way as the luminous paint on a clock face. To only a slightly lesser extent the pale whitish parts of the pattern

▷ *The genet: quick as a cat, curious as a mongoose, it even looks like a cross between them.*





on its body and tail also stand out in the dark. The best comparison is with the way the lights of a ship stand out on a dark night, so although the rest of it is obscured by blackness we still know it is a ship. So we can imagine a genet can recognise another genet in the dark by the ghostly white pattern of its body and tail, or, when seen head-on, by the white markings on the face.

Sure-footed night climber

The feline genet lives alone (at most in pairs) in bush country, sleeping by day among the branches and hunting by night. It can move swiftly over the ground, with the body held low and tail straight out behind, in an almost snake-like movement. It is most at home in bushes and trees, a skilful sure-footed climber, stalking its prey like a cat and seizing it with a swift sharp pounce. Normally it is silent but when alarmed or about to attack it purrs loudly with the sound of a kettle boiling, raising the crest on its back and fluffing the hair of its tail to form a 'bottle-brush'—typical mongoose behaviour when danger is imminent.



Jane Burdon, Photo Rex

Genets are typical carnivores and their canine teeth, though small, are needle-sharp. They feed on any small animal food, especially small rodents, birds and insects, particularly night-flying moths and beetles. A small amount of grass is eaten fairly regularly.

Hidden secrets of breeding

Little is known of the breeding. In the northern parts of its range the genet appears to have 2–3 in a litter, born in spring after a gestation of 10–11 weeks. The nest is in a hollow in a tree or among rocks. In South Africa, at least, there is a second litter in autumn.

Animal night-craft

We, who move about by day or carry a lamp at night, may wonder how an animal that hunts at night among branches can find its way so surely when moving at speed. Perhaps the behaviour of a tame genet tells us this. When first put into a strange room, with branches for it to climb over, the genet will make a circuit of the room, going over



Jane Burdon, Photo Rex

Fai left: After a stealthy stalk and quick pounce, a feline genet settles down to a meal. Left: Prey's-eye view: a genet's jaws show typical carnivore teeth, relatively small, perhaps, but needle-sharp. Above: Inquisitive, in a little way, a pair of genet kittens explore the world around them.

the floor and over every branch and other solid object. It goes very slowly, putting each foot down in turn and not putting its weight on that foot until it is sure of its foothold. At the same time it is investigating everything around, with its nose, probably also with its eyes; and since its ears are quivering all the time it is probably bringing the sense of hearing to bear as well.

Having thoroughly investigated the whole of its surroundings in this tediously slow and painstaking way, it repeats the circuit, this time going slightly faster. At the completion of this second circuit it makes a third, this time rapidly. From then on it can race around in total darkness and never put a foot wrong. So far as we can see it

memorizes the whole of its surroundings mainly by touch and smell, perhaps by sight and hearing to a lesser extent.

One genet, put into a fresh cage furnished with branches, slipped at one spot in its first circuit so that it swung under the branch and had to do a 'handspring' to regain its position on the branch. It lived many years in this same cage and always, whenever it came to this same spot on the branch, it swung under it and did a handspring, just as it had on the first occasion.

class	Mammalia
order	Carnivora
family	Viverridae
genus & species	<i>Genetta abyssinica</i> Abyssinian genet <i>G. genetta</i> feline genet <i>G. rubiginosa</i> rusty-spotted genet <i>G. tigrina</i> blotched genet <i>G. victoriae</i> Victorian genet <i>Osbornictis piscivora</i> water genet

Gerbil

Gerbils, or sand rats, live in desert or semi-desert parts of Africa and Asia. There are many species going by different names—usually describing their characters—such as naked-soled gerbils, fat-tailed mice, and fat sand rats. Two genera are known as gerbils, while another genus has been and not yet been recorded is called the *complanatus*. Gerbils are rat-like and belong to the same family as the kangaroo rat, but in some features of appearance and habits they resemble the jerboas or desert rats. The fur is brown on the upper parts, the hairs often tipped with black making it darker. The underparts are white. In most species the tail is long and slender, often with a small tuft of hairs at the tip, but the fat-tailed gerbil has a very short plump tail. The hindfeet are long, and with the long tail give the gerbils a kangaroo-like appearance.

Most gerbils are found in Africa, especially around the Sahara, but the large naked-soled gerbils live as far south as South Africa, spreading over most of the continent except the equatorial forests. These gerbils, also known as Indian gerbils, are also found in Asia from Turkey and Arabia to India and Ceylon. Others are found in Asia; great gerbils and Przewalski's gerbils are limited to the central Asian deserts of Mongolia, Turkestan and Iran.

Desert hopper

Although they are sometimes found in bush or scrub country, the typical home of gerbils is in the dry, sparsely covered regions around deserts. They have many of the features found in desert animals: the bullae or carbonates are large, indicating sensitive hearing and water is conserved so some gerbils can live almost indefinitely without drinking. They live in burrows and are usually nocturnal, so avoiding the worst of the sun's heat. Some species have hairy soles on their hindfeet which probably

insulate them from the hot sand and many travel by leaping when in a hurry. This is a common feature of desert rodents, such as the jerboa or the kangaroo rat of North American deserts, and is thought to be an economical method of moving about in search of the scant supplies of food in dry regions. The Indian gerbil has been given the name of antelope rat for it progresses in bounds of 15–16 ft.

The habits of gerbils are not well known as most are nocturnal, but many are now kept in laboratories as experimental animals and they are becoming popular as pets. They are expert burrowers and need to be kept in a cage with plenty of earth or sand. Some species make only a simple short burrow. The entrance may be blocked with loose earth, presumably to keep out either enemies or the heat. Other gerbils make complicated systems of burrows with several entrances, and chambers where they make their nests or store food. Often several gerbils make their tunnels close to each other, forming distinct colonies. Observations of great gerbils in winter showed that they never strayed far from their burrows. Footprints in the snow were never found more than 60 ft from a burrow's entrance and most trails never went this far. These gerbils became less active when temperatures fell and the snow became deeper. By midwinter only a few entrances remained open.

Food stored in burrows

Gerbils live mainly on the herbs that flourish in desert country during winter and spring. Leaves, seeds, flowers and roots of many different kinds of plants are eaten, and are often stored in the burrow for future use. The great gerbil stores winter supplies either in the burrow or just outside where they can easily be dug out of the snow: Over 100 lb of food has been found in one burrow. A few gerbils are also carnivorous. The short-eared gerbils sometimes feed on locusts and grasshoppers which they take back to the burrows and eat at the entrance, scattering the discarded wings and bodies. The Indian gerbil occasionally eats the young of its own kind and takes eggs and chicks from nests of birds.

Foot-stamping drummers

Some gerbils have breeding seasons restricted to a few months in the year, while others breed all the year round. The breeding habits of most species are unknown. Both sexes of the great gerbil mark their territories by rubbing their bellies on rocks, which transfers a musky secretion from glands on their bellies. A common habit of gerbils is to stamp their hindfeet, presumably to advertise themselves. It is possible to hear the slow, muffled thud coming from the burrows. The males will also fight, sitting back like kangaroos on their hindfeet while they bite and kick.

They may be several litters a year of 1–8 babies. The birth takes place after about 3 weeks gestation and the young stay below ground for about another 3 weeks. Then



- ◁ *Apprehension:* A gerbil swings onto its hindlegs to look round before bounding away.
▷ *Mid-leap:* *Cerbillus pyramidum* jumping.



they come to the entrance of the burrow and, after much hesitation, make short trips above ground. They gradually gain confidence and eventually start searching for their own food.

Agile enemies

Gerbils are eaten by all kinds of flesh-eating animals including snakes, foxes and shrikes. Their safety lies in being able to dash into a burrow or minking. Gerbils are very agile, being able to change direction at each bound, although the bat-eared fox (p 163) is skilful at out-jumping them. A fat sand rat will often stop at the entrance of its burrow and sit back on its hindlegs to peer at the source of disturbance before disappearing below ground. It would seem better to bolt straight in, and the Indian gerbil has short burrows, distinct from its main burrow, where it can hide when in danger. This gerbil is also said to be able to elude dogs by jumping on their backs and the naked-soled gerbils of Nigeria escape by suddenly leaping to one side and hiding motionless in the cover of grass.

Plague carrier

Gerbil activities sometimes clash with man's interests. They are occasionally a pest to crops or desert reclamation schemes. In Iraq the jird steals grain and stores it in temporary burrows in the fields. Later it removes its booty to permanent stores under stones, where it may be stolen by hamsters. Much more serious pests are the gerbils of South Africa. They are carriers of bubonic plague and ceasing efforts are made to control their numbers.

It is the general rule for small desert animals to come out from their holes at night (see fennec, p 747) but several species of gerbil are diurnal. The fat sand rat can be seen out feeding even during the heat of the afternoon. The intense sunlight in the desert can damage an animal's tissues because some of the radiation is able to penetrate very deep into the body. Nocturnal activity removes this risk. Some observations by a Russian zoologist suggest that the diurnal gerbils are protected from the harmful effects of the sun. The midday

jird has very dense fur, with nearly twice as many hairs per square inch as a coypu, which is noted for its thick fur. It also has a thick skin. This is unusual as thick-furred animals usually have thin skins and vice versa. The great gerbil, another diurnal species, has layers of pigment in the skin that prevent the harmful rays from penetrating, whereas the nocturnal gerbils that were studied had no such protection.

class	Mammalia
order	Rodentia
family	Cricetidae
genera & species	<i>Gerbillus gerbillus</i> pygmy gerbil <i>Meriones meridianus</i> midday jird <i>Psamomys obesus</i> fat sand rat <i>Rhombomys opimus</i> great gerbil <i>Tatera indica</i> Indian gerbil others

Rough but effective: a female gerbil drags her babies to safety after being disturbed. They are helpless until about 3 weeks old.



Gerenuk

Also known as Waller's gazelle or giraffe-necked gazelle, the gerenuk was not set on scientific record until 1878. It is often said that the gerenuk was known to the Ancient Egyptians and was figured in their tombs. In fact only one Egyptian antiquity has been discovered bearing a representation of a long-necked, long-legged antelope and this is more likely to have been the dibatag (see p 631).

The gerenuk stands up to 41 in. at the shoulder, the length of head, neck and body totals 4½ ft, the tail is 9 in. long and the weight up to 115 lb. The male carries short, thick, lyre-shaped horns up to 17 in. long. The coat is fawn red on the back, lighter along the flanks and white on the underparts.

Sir Walter Brooke first described the gerenuk from specimens sent to him by a missionary, the Rev Horace Waller, a friend of David Livingstone. Waller had received them from Sir John Kirk, British Consul in Zanzibar, the specimens having come originally from the coast of Somalia. Brooke gave them the name *Gazella walleri*. An Austrian scientist, Dr Kohl, studied their anatomy and concluded they were not gazelles. One feature he noted was that the skull extended unusually far back behind the horns and that this part was almost solid bone. So he changed the name to *Lithocranius* (stony skull) *walleri*.

The horizontal position . . .

Gerenuks are excessively shy and readily move away trotting with the head held horizontally forward, so they easily pass under low branches in the thorn bush. A gerenuk when disturbed moves away about 200 yd then stops and raises its head from behind a bush to survey the intruder.

Gerenuks live singly, in pairs or in small herds of 3–10 in the drier parts of southern Ethiopia, Somalia and northern Kenya.

. . . and the vertical

Gerenuks browse foliage, especially acacia, with their long, hairy mobile lips and long tongue. Characteristically a gerenuk will stand on its hindlegs to reach leaves 6 or 7 ft up. They may place the front hooves on the trunks to do this. Where water is available they will drink, but in the drier parts of their range they seem to go long periods without drinking. In the Frankfurt Zoo it has been noticed that gerenuks will drink each other's urine, which may be a means of water conservation in the wild.

Wife-kicking

Although Kohl decided the gerenuk was not a gazelle it has one trick which is seen in Thomson's and Grant's gazelles of East Africa. Before mating the buck throws a front leg forward in the direction of the doe, but instead of inserting it between her hindlegs, as the two gazelles do, he aims it

▷ Female gerenuk and young.





D. Owen

at her forelegs or flanks. Then he nibbles her muzzle and rubs his head against her, particularly the part of his face just in front of the eye, which is marked with a dark patch. This is the opening of a scent gland, the preorbital gland. In other antelopes it has been found that when the buck's scent is rubbed onto the head and the neck of the doe it brings her more quickly into breeding condition.

There is relatively little information on breeding. Females in zoos had bred for the first time at 19–22 months and, in the wild, the young are born in time to browse the tender new shoots that appear with the rains.

There is no precise information about enemies, but presumably these include any carnivores in their range large enough to take either the kids or the adults. The Somalis refuse to eat the flesh of the gerenuk believing it is a relative of the camel and that if gerenuks are killed, sickness will afflict their camels.

Fauns and satyrs

The most striking thing about the gerenuk is that it can, and habitually does, stand erect on its hindlegs with the neck, back and hindlegs in a straight line. This, however, is not so astonishing as those freak quadrupeds which always walk on two legs. They

show how readily an animal can pass from the quadrupedal to the bipedal posture. The most famous of these is known as Slipper's goat.

Professor EJ Slipper wrote in a Dutch scientific journal in 1942 about a he-goat born without forelegs. It lived for a year, and even then only died of an accident. It moved about by jumps on its hindlegs in a semi-upright posture, its body making an angle of 45 degrees with the ground, the hoofs of the hindlegs placed much farther forward than usual to bring them under the centre of gravity.

Buried in various scientific journals in Britain, France, Germany and the USSR are similar accounts of dogs, horses, sheep, goats, cats and other domestic animals born without forelegs or only stumps and compelled to walk erect or nearly so. One dog lived for 12 years despite the handicap.

There is a further interest in this. If this can happen to domesticated animals it could also happen to wild animals. They might not survive so long, especially those like dogs or cats which must hunt for a living. But a herbivore, like a goat, might well survive, and one wonders whether stories of fauns and satyrs may not have sprung from the sight of a bipedal goat. Even the great god Pan may have been nothing more than a Slipper's goat living in classical times.

Full stretch: noses buried in foliage about 7 ft from the ground, a gerenuk couple browse in satyr-like poses.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus	
& species	<i>Lithocranius walleri</i>





Gharial

The gharial is a long, slender-snouted crocodile living in the rivers Indus, Ganges and Brahmaputra and in a few other rivers of this same region. The alternative name of gavial, although Latinized to give its scientific name, was originally due to a misspelling.

The Indian gharial can grow to 20 ft in length. The eyes are set well up on the head and the nostrils are at the tip of the long slender snout. The jaws are armed with small sharp teeth of nearly uniform size. The upper surface of the neck and the back have an armour of bony plates. The legs are longer proportionately than in most other crocodiles and the toes, especially those of the hindfeet, are webbed.

A crocodile very similar to the gharial lives in the rivers and marshes of Malaya, Borneo and Sumatra. Its snout is long but proportionately shorter than that of the gharial, and the two are similar in habits. It is, however, known as the false gharial and is one of the crocodile family (see p 575) or *Crocodylidae*, while the gharials have a family of their own, the *Gavialidae*.

Inoffensive crocodiles

Gharials keep to the water more than other crocodiles. They tend to lie just under the surface with only the eyes and nostrils exposed. When anyone approaches, the eyes sink slowly out of sight, leaving only the nostrils breaking surface. With the closer approach of an intruder the tip of the snout is then submerged. Both gharial and false gharial are little danger to people although there are rare records of fatal encounters. The gharial is sacred to the Hindus, and although its stomach is sometimes found to contain articles of personal adornment, such as bracelets, these have come almost certainly from human corpses committed to the sacred River Ganges.

Handy snout for feeding

The food of the gharial and false gharial is almost entirely small fishes, seized with a sideways snap of the jaws. The slenderness of the snout allows quick movement sideways; it is easier to wave a stick from side to side in water than a plank.

Two-tier incubator

The male gharial has a hollow hump on the tip of the snout with the nostrils at the centre of it. Otherwise there is little outward difference between the sexes. In the breeding season the female lays about 40 eggs in sand on a river bank, each 3½ in. by 2½ in.

△ Gharial siesta, slumped on a warm bank to make the most of the midday sun.

These are in 2 layers, probably laid on separate days, and each layer is covered with a fairly deep covering of sand. The newly-hatched young, 14 in. long, have absurdly long snouts and they are coloured greyish-brown with five irregular dark oblique bands on the body and nine on the tail. The adults are mainly dark olive.

Same head, same feeding

Crocodiles in general and then immediately recognisable ancestors have a very long history going back over 200 million years. The crocodiles proper, living today, which must include also the caimans and alligators, do not differ much from their earliest ancestors, except that some of the extinct crocodiles are larger than the largest living today. There was, however, a separate group of crocodilians whose fossils also date from those very early times, known as the *Mesosuchia*. They also had 'irving-pani' heads like the gharials, but they lived in the sea and they died out 120 million years ago. The gharials came into existence much later, less than 70 million years ago, and one of them was 54 ft long, the largest crocodilian we know of, living or extinct.

The *Mesosuchia* and the gharials are,

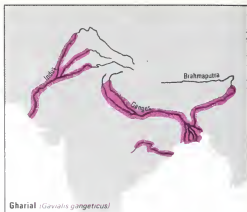
apart from being members of the order Crocodylia, not related. But they both had the long slender snout and both had many small sharp teeth. They both had the same feeding habits, seizing fast-moving slippery prey with a sideways slash of the head. We know gharials do this because people have watched the living animals feeding. We know false gharials do also, for the same reason, and we can deduce the Mesosuchia did this from the finer details of their bones. So we have three kinds of crocodilians with the same shape of head, feeding in the same way but all three unrelated. We know the gharials snatch fish; we can deduce the Mesosuchia snatched squid.

Many animals have pebbles in their stomachs. Living crocodiles are one example. Living crocodiles are another, and

we know this because when their skeletons are dug out of the ground groups of pebbles are found lying where the stomach would have been.

How do we know the Mesosuchia ate squid? Because the stomach stones found where their stomachs would have been are stained with the ink contained in the bodies of squids.

class	Reptilia
order	Crocodylia
family	Gavialidae
genus	
& species	<i>Gavialis gangeticus</i>



Gharial (*Gavialis gangeticus*)

▽ Fish trap: once caught in this array of vicious teeth by a sideways slash of the gharial's head, few fish, slimy or not, can escape.



Ghost frog

The ghost frog of South Africa gets its name from the white skin of its underside, which is so thin that the digestive organs are visible through it. Its back is green, marked with a reddish network. Compared with other frogs, its body is small relative to the head and unusually long legs, and there is almost a suggestion of a neck. The head is flattish with the eyes more prominent than is usual in frogs, and the toes of all four feet end in discs. When an animal species is placed first in one family, then in another, it usually means that its relationship with other animals is not clear. Some scientists put the ghost frogs in a family of their own, the *Heleophryinae*, others put them in the *Leptodactylidae*, but all leading authorities now agree on the latter. The animals normally end up in a genus of their own. This is true of the ghost frogs, of which there are three species. One species *Heleophryne rosei* lives on Table Mountain, another *H. purcelli* is found in Cape Province, and the third *H. natalensis* is in the Transvaal and Natal. The frogs are elusive in another way: they are very hard to find, but the real reason for their name is that you can almost see through them.

Equipped for climbing

Ghost frogs have toes shaped like those of tree frogs, although they climb little. Instead, they tend to spend the day crouching in holes in the ground, under stones or in caves, and they also spend much of their time in water. At night they come out and clamber over large rocks or into trees. Another unusual feature is that the skin of the undersides of the forelimbs and the tops of the fingers has groups of small hooks, and similar hooks form a double row on either side along the lower jaw with scattered hooks on the upper jaw and the snout. It has been suggested that these help the frog to cling to the surfaces of slippery rocks. This description applies to the best known of the ghost frogs, *Heleophryne rosei*. Another species also has spines on the skin, and this one climbs into bushes.

Mainly insect-eaters

Frogs shed their skins periodically and in most species the frog eats the cast skin, which is sloughed more or less in one piece. Ghost-frogs shed their skins in pieces and make no attempt to eat them. It should be emphasized, however, that in this as in everything else concerned with their biology we have only a small amount of information. Ghost frogs are difficult to track down and are rarely seen. Possibly part of the explanation is seen in their eyes, diamond-shaped with the long axis of the diamond vertical—an unusual eye, showing nocturnal habits.

Ghost frogs probably eat insects, and one species *H. purcelli* has been seen capturing flies by leaping up at them.



John Vassler

The ghost frog gets its name from the white skin of its underside. It is very difficult to track down and as a result is rarely seen. This may be partially explained by the fact that it is nocturnal—as shown by its diamond-shaped pupils formed during daylight to keep out bright light.

Holding on to food

By dissecting the dead female ghost frog it is known that she lays about 30 large eggs. Where she does this is not known, and the guess is that she lays them in a hole in a river bank just above water level. More is known about the tadpoles which are somewhat flattened, especially in the head. Seen from above they are wedge-shaped except for the tail. Around the mouth is a large sucker by which the tadpole can cling to submerged rocks and browse the small algae on their surfaces.

Mountain chicken—frogs of the West Indies

Those not versed in field natural history may wonder why, once a species is known to exist, somebody does not set to work to learn all about it. To illustrate the difficulties we cannot do better than tell the story of the mountain chicken of the West Indies. This is a frog *Leptodactylus jamaicensis* which belongs to the same family as the ghost frogs if we accept the majority view. It is nearly 6 in. long, weighs up to 2 lb and lives on the islands of Dominica, Montserrat and Martinique. The frog lives in the steep-sided valleys which are heavily forested and difficult of access. During the day, so far as anyone can tell, it rests in burrows in the ground or in cavities among boulders. The females have never been seen and nothing is known of the way they breed. They do not live near streams, so possibly they make foam nests in the trees like related species living in South America are known to. The males come out at night and call

with a musical, bird-like 'song', but the reason why they are called mountain chicken is that the flesh of their legs cooked with egg and bread crumbs is delicious, like the best chicken. The frog has been almost eliminated from Martinique, partly because introduced mongooses have preyed on them and partly because they are much prized for the table.

An English zoologist visiting Dominica tried to find the females in the hope of studying the life history of the species. He found some of the males, but even this entailed climbing the steep slopes at night in rain, negotiating tangles of tree roots, creeps and boulders, finding his way by electric torch and guided by the somewhat ventriloquial musical calls of the males, which go on singing all night. Even to find a few males was a small reward for all the effort and discomfort he expended. The males themselves do not help because they tend to sit near the mouth of a burrow or cavity among the boulders into which they can readily retreat.

After all, if you can only find males your knowledge of a species must be very incomplete. And if you eat those males it cannot be long before a population of spider-frogs is created—and that means the end of the species.

class	Amphibia
order	Salientia
family	Leptodactylidae
genus	<i>Heleophryne natalensis</i> <i>H. purcelli</i> <i>H. rosei</i>

Ghost moth

Swinging to and fro, as if on an invisible thread, with the white uppersides of its wings flashing on and off, this moth is aptly called 'ghost'. It is one of the five species of *Hepialus* found in Britain and is remarkable for the great difference in appearance between the male and female. Males have the uppersides of all four wings shining white. Females have the hindwings dusky and the forewings yellow with a pattern of reddish markings, and they are generally larger than the males. Ghost moths are $\frac{1}{2}$ in. long with a wingspan of just under 2 in. They are found throughout the British Isles and all over central Europe and western Asia. The larva is a large, whitish, rather grub-like caterpillar, with a brown plate on the segment just behind the head. It lives underground.

Spooky husbands

Ghost moths frequent open spaces where rough grass and weeds are allowed to grow, and are on the wing in June and July. The males execute a kind of aerial dance, swinging to and fro just over the herbage as if suspended on invisible threads. As they fly they vanish and reappear as the dark underside and white upperside of the wings are alternately exposed. The dance is performed for about half an hour after sunset and again shortly before dawn; at other times the moths hardly fly at all. It is a courtship display and serves to attract the females, which fly about the countryside and are guided visually to their palely glimmering partners, their search being assisted by a scent, given off by the males, that has been likened to that of a carrot. This is one of the few cases known among insects where the females fly in search of the males. More usually female insects remain static in courtship and the males are attracted to them, in most cases by the emission from the female of a specific scent.

Non-hopping moths

The eggs are laid at random among grass in June and early July and the larva feeds underground on the roots of various plants until May of the next year, when it pupates in the burrow that it has made. The adults have vestigial mouthparts and do not feed. There is no association with the hop, as the specific name *humuli* suggests.

Shetland ghost moths

In the Shetlands a peculiar race of the ghost moth is found, in which the males differ in their colours from the ghost moths of both the British and the European mainlands. It is regarded as a subspecies and has been named *H. humuli thalensis*. The hindwings of the males are dusky and the forewings dull white with a brown or ochreous pattern similar to that of the female.

The shining white coloration of the typical male ghost moth is not characteristic of



△ Male ghost moth. In June and July the males execute a kind of aerial courtship dance. This serves to attract the females who fly in search of these glimmering partners.

▽ The female is slightly larger than the male usually being $\frac{1}{2}$ in. long with a wingspan of just under 2 in. After mating she lays eggs at random among grasses and herbs.





△ In the courtship dance the male swings to and fro just above the herbage as if suspended on invisible threads. The dance is performed for about half an hour after sunset and again shortly before dawn. At other times they hardly fly at all. The dance attracts the females, helped by a carrot scent given off by the males.

swift moths in general. Presumably it is maintained by natural selection, on the principle that the most conspicuous of the twilight dancers will be more readily found by females and so are most likely to leave progeny. In the almost Arctic latitude of the Shetlands, however, where there is no darkness at midsummer and the sun disappears at midnight for only half an hour, the males must perform their dance in broad daylight. They do not need the porcelain-white wing colour of their relatives farther south to make them visible to the questing females. The selection pressure being relaxed, it is supposed that the males have reverted to an appearance more characteristic of the Hepialid moths in general, probably more like that of their ancestors.

This is, however, an academic point and there is another, more practical explanation. In the Shetlands ghost moths are heavily preyed upon by gulls, which by flying above the moths will see white individuals more readily than darker ones against the background of heather, rock or peat. In these circumstances the pure white coloration is a definite disadvantage. Here the tables are turned. The white males are more likely to make a meal for a gull than a mate for a moth, and therefore are less likely to leave progeny.

class	Insecta
order	Lepidoptera
family	Hepialidae
genus	
& species	<i>Hepialus humuli</i>

G. E. P. / NY



▽ Ghost moth larva—a large, whitish, rather grub-like caterpillar—it lives beneath the ground feeding on the roots of plants such as burdock, dandelion and dead-nettle.

Giant forest hog

This forest hog, the largest wild pig in the world, was nearly become extinct before the western world ever knew about it. It was unknown to Europeans until 1904 when a skull and pieces of skin were given to Colonel Richard Meinertzhagen by the local hunters of the Kakamega Forest in western Kenya. Since then it has been found on Mount Kenya, in the Aberdare Mountains and in the mountain forests of Uganda and eastwards through the Congo to Liberia.

A large boar may be 5 ft long with a 43 in. tail, 3 ft high at the shoulder and weigh up to 600 lb. The body is thickset, the head broad and stout, the chest-coloured skin covered with long black bristles. The snout is heavy, with large upper tusks growing out at right angles. The skin in front of the eye is naked, and behind each eye is a pair of warts. These are much the same as the warts on the face of the war pig, differing but their position and shape is different—and nobody knows what they are for. On the naked skin in front of the eye is a slit, the entrance to a funnel-shaped gland which no other pig has. Another unusual feature is that on the top of the head is a deep depression 'large enough to take a tangerine orange', as one French zoologist put it.

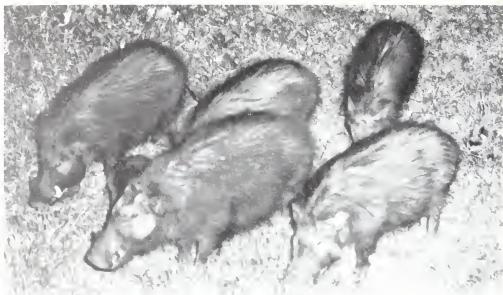
Pig with clean habits

Forest hogs, sly and retiring, move about in groups or 'sounders' of 4–20 in dense undergrowth of rain forests, where they have their runs and bedding-down places. They also frequent swampy places to wallow. They seldom use a burrow and even less do they construct one, but they dig holes at the bases of trees to use as latrines. Their usual habit is to keep well out of sight but old boars brought to bay by dogs or wounded can be dangerous. They have also been known to attack humans in defence of the sounder.

Little more is known about them except that they feed mainly on lush grass and shrubs, and unlike most species of wild pig do not root in the ground for food. They come out of the dense undergrowth in the early morning to feed, and again in the late afternoon and evening. The litter is max. con. 2–6 young, born after a gestation of 125 days.

Tracking it down

The story of why so little is known about these giant hogs is one of the most romantic in the annals of large mammals. Several of the early explorers in Central Africa, including Sir Henry Stanley as well as Sir Harry Johnston, who discovered the okapi, had heard stories about it from the Africans but none had been able to see it. Then, in 1903, Colonel (then Lieutenant) Richard Meinertzhagen, a professional soldier, since famous as a naturalist and author of books on birds, heard about it when he was in Kenya. He determined to find it but bad luck dogged him. First he heard one had



A sounder of giant forest hogs on a night feeding expedition. A sounder is made up of 4–20 hogs. The largest wild pig in the world, a large boar may be 5 ft long and over 600 lb in weight.

been killed by African hunters but by the time he had reached the spot the carcase had been carved up and all he could get were two pieces of the skin. A little while later he heard of another having been killed. This time he got some of the skin and also the skull. These few relics, and especially the skull, were enough to show the animal belonged to an unnamed species, so Meinertzhagen sent them to London where they were shown to the Fellows of the Zoological Society. An account of them was published in that Society's Proceedings for 1904.

The pig that nearly died out

In following years several more skulls as well as drawings of the animal were sent to the Natural History Museum in London. Occasionally white hunters in Central Africa had a sight of it, and people who visited Tree Tops, the Lamons look-out in Kenya, were sometimes able to see it. All the same, the giant forest hog is one of the rarer animals. So far as it has been possible to piece the story together it seems that it used to be much more numerous. Then, in 1891, the disease known as rinderpest swept across Africa and the giant forest hog suffered so badly that it is now rare.

Colonel R Meinertzhagen who tracked the hog.



Fact and fable

Many of the stories told to the early explorers by the Africans were highly coloured as to the hog's ferocity. This was the natural reaction to being attacked unawares. For example, the women going into the forest to gather firewood were sometimes ambushed. Although some of the estimates of its size given by the Africans proved accurate, others were often badly exaggerated. This also is the reaction of people everywhere to mystery animals. Nevertheless, there could in this instance be some justification, for, as a result of Dr LSB Leakey's discoveries in Kenya in the last 20 years, we now know there used to be giant animals in that part of Africa, including hogs the size of a rhinoceros or hippopotamus.

class	Mammalia
order	Artiodactyla
family	Suidae
genus	
& species	<i>Hydrochoerus meinertzhageni</i>

The distribution of the hog is localised.



Giant rat

Some rats are little bigger than mice, but others are nearly 3 ft long and have deservedly been called giant rats. A few not quite as long as this have been called giant rats, but one that deserves the title is the African giant pouched rat, also called the Gambian pouched rat. It is found from Gambia in the west to the Sudan and Kenya in the east and southwards to the Transvaal. It is nearly 3 ft long of which just over half is tail. Its fur may be sleek or harsh, grey to brown on the back, lighter on the flanks and whitish on the underparts, with the feet and legs noticeably white or pink. Some are mottled, almost spotted. The head is long and narrow and the ears large. The tail is naked.

The Gambian, pouched or African giant rat, numerous over so wide an area, has many local names, in the African languages as well as in English. In Sierra Leone it is the ground pig, in Ghana the bush rat. In northern Nigeria it is the bandicoot and in western Nigeria the rabbit.

Short-sighted giant

The African giant rat lives in the rain forests of west central Africa, in the bush, on farms, in grassland, under piles of logs, even on the summits of the huge bare rocks, known as insulbergs, standing in the savannah. It is solitary, living in a burrow that may have 2-6 entrances, and it is said these are often closed from the inside with leaves. Mainly active at night, it may sometimes be seen by day sitting on its haunches, sniffing in all directions as if blind, despite its bright eyes, and it can be seen doing exactly the same at night. This suggests it is very short-sighted and doubtless depends mainly on its nose and, more especially, its large ears, which are constantly on the move. When running it holds its tail well up. It is wholly inoffensive and docile, and can be picked up by the tail and handled without fear of its biting. When not feeding it keeps up a constant bird-like chirping.

Built-in shopping bags

The food of the giant rat is any plant material, especially grain, fruits and nuts. It is called the pouched rat from its capacious cheek-pouches, which have earned it the additional name of hamster rat. It stuffs these pouches with food until its face is twice the normal size, then runs away and, working the food forwards with its paws, spits it out in a heap to store it.

Pink and white rats

The breeding season seems to vary from one part of its range to another. Usually 2-3 young are born at a time after a gestation of about 42 days. They are pink and white at first, the body and head about 4 in. long with a tail half as long again. Brown fur begins to show at about 3 weeks.

African 'small beef'

Little is known of natural enemies but they must include almost any local beast or bird

of prey. Their greatest enemy is probably man, since the Africans regard their flesh as a delicacy and dig the giant rats out of their burrows. To them the flesh is 'small beef'.

Many island giants

By contrast with the giant pouched rat the five species of giant naked-tailed rat, or African big-toothed mouse *Uromys*, only 8½ in. long overall and covering much the same range, are all rare. They are hardly worthy of the name of giant. For really big rats we need to go farther west, to the islands of the Indo-Pacific. The New Guinea giant tree rat *Mallomys rotchschilli* lives among rocks 1-8 thousand ft up and feeds on plants, especially fern shoots. It is 34 in. overall with thick woolly brown to grey fur, a scaly tail and long curved claws.

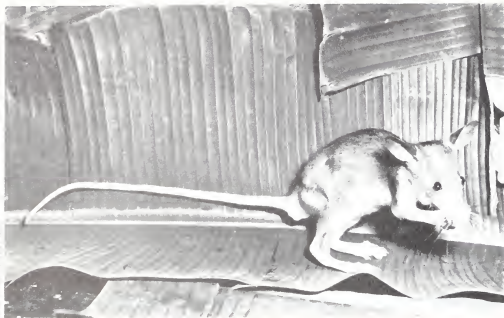
Another New Guinea giant rat is *Hypomys goloth*, grey with light underparts and also nearly 3 ft total length. Little is known of the

habits of either of these giants. A third species on New Guinea is the giant naked-tailed rat *Uromys caudimaculatus*, 28 in. long, of which half is tail, and there are species related to it on the islands of Aru and Kei, of the Bismarck Archipelago and the Solomons, as well as in Queensland, Australia. Again little is known about them. There is a giant tree rat *Papagomys armandvillei* on the island of Flores of which practically nothing is known and very few specimens have been obtained. On the island of Luzon, in the Philippines, are two species of cloud rat, both nearly 3 ft long, one of them with a bushy tail, and this one is trapped by the aboriginal inhabitants of the island and their pelts sold in the markets. Yet we are in almost complete ignorance of how they live.

There are three species of giant water rat: one in New Guinea, one in New Britain and the third in Australia and Tasmania and also on a number of the islands to the north of Australia. A little more is known about

Giant rat or Gambian pouched rat youngster stuffs its food pouches with food. It will push in fruit, grain and nuts until its face is twice the normal size before going off to store it.





these, but still not very much. They are nocturnal, sleeping by day in a burrow in the bank, a hollow log or under a pile of vegetable litter, and they feed on water snails, mussels, fish, frogs and water birds. They have a long flattened head, eyes set high up on the head, small ears and seal-like fur and their feet are partially webbed. Starting in 1937 they were extensively trapped in Australia for their fur and now they have to be protected.

class	Mammalia
order	Rodentia
family	Muridae
genus	<i>Cricetomys gambianus</i>
& species	<i>others</i>

◁ Baby giant rat.

▽ Cocoa bean investigation: this giant rat may be eaten by Africans who regard its flesh as a delicacy—to them it is 'small beef'.



Giant snail

A pest in many parts of the world.

Achatina fulica is a large land-living snail, native to East Africa. With its pointed shell, 5 or even 8 in. long, it weighs about $\frac{1}{2}$ lb. This species deserves the title of giant snail, although there are other large terrestrial snails in many of the warmer countries, because of its notoriety and economic importance. The fact that even larger snails live in the sea seems somehow less remarkable.

In other respects, there is little of note in the appearance of the giant snail as compared with the snails of our gardens.

Dusk feeder

The giant snail feeds mainly by night or at dusk, usually returning after its forays to a regular 'home'. However, it will also come out by day if there is rain or if the sky is overcast. For continued activity, dampness and a temperature above about 24 C/75 F are needed. On the other hand, during dry or cold periods it remains inactive, often deep in some hollow log or under a rock and withdrawn into its shell, the aperture closed off with a thin membrane. This state of inactivity, or aestivation as it is called, has been known to last for as long as a year—a long enough time, but not to be compared with the 6 years recorded for an individual of another species of snail. When so much time can be spent in suspended animation, records of longevity have little meaning, but one specimen is recorded as having lived 9 years in captivity.

A taste for whitewash

To a large extent the giant snail feeds on rotten plant matter and dead animals but it will also feed voraciously on the leaves, fruit, bark and flowers of a great variety of plants—including, unfortunately, crops like beans, breadfruit, cabbage, cacao, citrus trees, melons, yam plants and rubber. Needing calcium to form its shell, it may even climb walls of houses to ravage the whitewash on them for its lime content.

Pea-sized eggs

These giant snails begin breeding when about a year old and, like their smaller relatives, are hermaphrodite. They lay eggs the size of small peas, like miniature bird's eggs with lemon-yellow shells. These they deposit, 40–500 at a time, in or on the soil, doing so every 2 or 3 months. The young hatch in 1–10 days. A single snail can apparently lay eggs without mating after months of isolation, for evidently sperm can be stored for this time before being used. One result is that a single snail can suffice to found a new colony if it was fertilised before being transported.

Growth of a pest

In its East African home, the giant snail is hardly a pest, but it has spread from there to many of the warmer parts of the world, becoming in most of them a considerable pest. Like the rabbit in Australia,

it is one of too many examples of animals or plants, originally fairly innocuous, that have become pests outside their native lands. Everything about this snail, such as its ability to eat almost any plant material and its high rate of reproduction, combined with its hardness and a scarcity of natural enemies, favour its chances of colonising new areas, provided that the climate is suitable. Just a few individuals need be introduced—even one is enough.

The spread of the giant snail started in about 1800 when some were taken to Mauritius by the wife of the governor on doctor's orders (medical properties have been ascribed to these snails as to others). There they multiplied and became a pest. Some were taken to the island of Réunion and to the Seychelles and, in 1847, some were released in Calcutta. From then on the snail has appeared in more and more countries—particularly in the Indo-Pacific area, including Malaya, Indonesia, the Philippines, Thailand, Vietnam, and China.

more than offset by the damage they can inflict on crops and gardens, for they can occur in huge numbers, like apples under an apple tree.

The nuisance does not end there, for in places the ground may become slippery with slime, excreta and dead snails, and roads in Ceylon and Saipan have been turned into 'stinking nightmares' as more and more were attracted to their crushed fellows. Worse still, the slimy mess provides breeding grounds for disease-bearing flies. With others dying in drinking wells, decontaminating with impunity the warfarin bait and springing the traps put out for rats, it is hardly surprising that much effort is devoted to their control. Poisons have been used as well as various predators—including other carnivorous snails—but always there is the danger in these methods of upsetting the balance of nature in yet other ways, such as the controlling predators attacking innocuous species, and so becoming pests themselves. The best method of all,



This West African giant snail has a pointed shell 5–8 in. long and weighs about $\frac{1}{2}$ lb. Introduction into many parts of the world mainly for its food value has resulted in it becoming a pest.

Sometimes introductions have been accidental, the snails being transported while aestivating in bananas, in soil, or in motor vehicles. Sometimes they have been deliberately introduced. In 1928, for instance, they were introduced to Sarawak to be used as poultry feed and in 1936 to the Hawaiian islands by a lady wishing to keep two in her garden as pets. The Japanese forces took them as food for themselves into New Guinea and elsewhere and, before the Second World War, they were eaten by Malays and by Chinese in various places. Other related giant snails are important as food in parts of West Africa. In Ghana they are the greatest single source of animal protein. The value of snails as food, however, even to those willing to eat them, is

if it can be used in time, is a rigorous system of control to prevent the spread of the snail. It is encouraging that, in some areas, after an initial heavy infestation, the population diminishes to a steady level at which they are not such serious pests.

phylum	Mollusca
class	Gastropoda
order	Stylommatophora
family	Achatinidae
genus	<i>Achatina fulica</i> East Africa
& species	<i>A. achatina</i> West Africa



Gibbon

The most agile of mammals and smallest of the five apes (including man) the gibbon is distinguished by its extremely long arms, which may be $1\frac{1}{2}$ times the length of the legs. Most gibbons are about 3 ft high when standing upright, but the largest species, the siamang, reaches 4 ft. The fingers are long and the thumbs appear long because they are deeply cleft from the palms of the hands. The thumbs are also very mobile and gibbons are adept at manipulating objects. The nails are clawlike and the fangs, which in other apes are long in the males and short in females, are long in both male and female gibbons. As the males are only slightly larger than the females, the sexes tend to look alike except for their colour.

The six species of gibbon live in south-east Asia from Assam south to Java. The siamang lives in Malaya and Sumatra and the dwarf siamang lives on some small islands west of Sumatra.

The species differ in colour. The siamangs are entirely black. The males of the concolor, hoolock and black-capped gibbons are black and the females fawn. Both sexes of these gibbons are whitish when born, turning black in their first year. At maturity the males remain black while the females turn fawn. The sixth species, the lar gibbon, the one most often seen in zoos, has several races. The white-handed and agile races of Malaya and Sumatra have light and dark colour phases, independent of sex. The silvery gibbon of Java and Borneo is uniformly grey or brown. The concolor gibbon differs in that the male has a crest of hair.

Superb acrobats

Gibbons live high in the trees, where they travel by swinging by their arms. They are popular in zoos for the way they will swing from one end of the cage to the other, grabbing bars with their hands and throwing themselves forwards without a check in their progression. Their agility is quite incredible, as they make apparently effortless leaps of 30 ft or more, and their reflexes match it. A gibbon was once seen to jump from a branch just as it broke, and so fail to get enough momentum to reach the next branch. Twisting in mid-air, the gibbon grabbed the stump of the broken branch, swung right around it and flew off to its destination. The gibbon's agility is mainly due to its long arms, which can move freely in all directions, its light body and the long fingers that are held in a hooked position with the thumbs out of the way. Gibbons are also agile on the ground. Apart from man, they are the only apes that

◁ The swinging primate: the ability to swing hand over hand is the art of the gibbon. Its wrist, long arm and shoulder are adapted for this movement, known as brachiation.

▷ Almost human: a silvery gibbon stands erect.





Geoffrey Kimmis



Shirley & Patricia Ocker, Singapore



At home with the gibbons

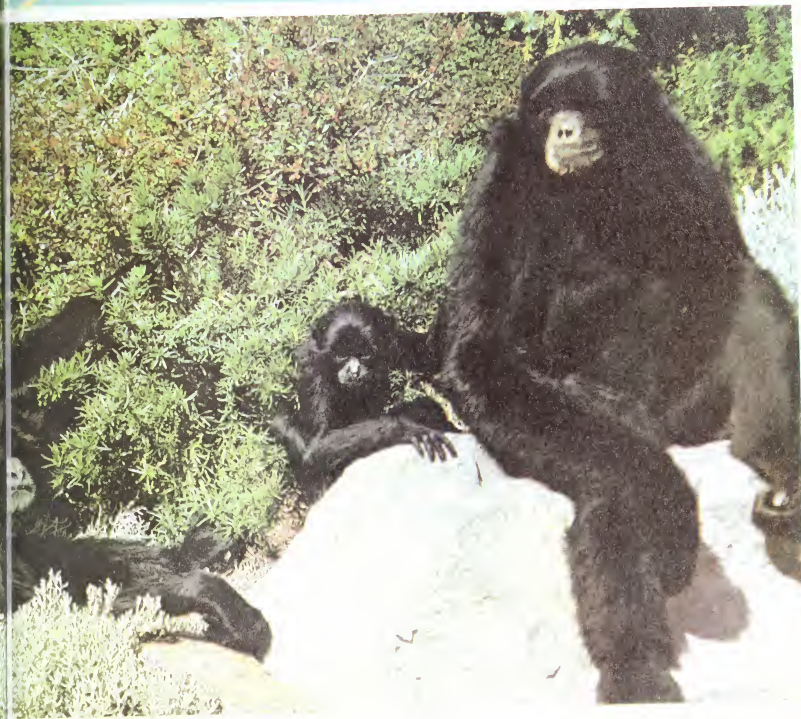
A 6 day old gibbon clings instinctively to its mother (above). The mother will lavish intense care on her offspring until it is weaned.

Portrait of a lar gibbon (above center). The eyes are designed for binocular vision. They are forward directing giving overlapping sight which enables the gibbon to focus accurately on branches it is aiming for in its aerial acrobatic movements (above right).

Siamang family (right). The siamang is the largest of the six gibbon species with an arm-spread of as much as 5 ft. It has a throat sac which can be inflated to about the size of its head when a call is given. This call has been described as the combined bark of a dog and the howl of a grouse. In the early morning all the members of a family give a short "concert", howling in unison for several minutes. This noise carries for considerable distances - often over two miles. The map marks (left) show the positions of recorded specimens. Apart from the siamang which is rather different from the others, the species of gibbon have separate ranges which overlap only slightly so there is no real competition.



© Dennis



habitually walk upright on their knuckles. When walking on the ground or along a branch they hold their arms out to help in balancing.

Other apes are becoming rare, but the gibbon is still quite numerous in the wild. Soldiers returning from Vietnam often bring home pet gibbons. They are now the best of pets, the females in particular being lively in fits of bad temper, but the males usually become tame and affectionate.

Gibbons live in small groups, often a pair with up to four offspring. Each group owns a small territory, varying from 10 to 300 acres. They sleep in the centre of the territory, huddled together on a branch, squatting on their scial cushions or sitting pads—furred patches of skin on their rumps. Gibbons probably mate for life and they are very aggressive to other gibbons. Each morning, some, usually the females, begin calling, uttering the "scream" which is said to be an advertisement. This attracts the groups towards each other and they often meet at the boundaries of their territories. The males leap about among the branches, all a series of hoars, and eventually one male may chase another, forcing him back into his own territory, then rapidly retreating. Vary occasionally there is a fight and the two males scuffle and bite each other. After an hour or so the conflict is over and the groups wander back into their territories to feed.

Each species of gibbon has a very characteristic "scream" by which it can be recognised, even if the gibbons are hidden in the tree canopy. The black-capped gibbon has the most musical call consisting of a rising crescendo of wistful-sounding whoops followed by a rapidly descending series. The hooleck gibbons produce a call that is imitated by the name. It is stimulated by another gibbon calling or by a sudden change in the weather such as a shower of rain or the appearance of the sun. The siamang has a special throat pouch. Filling it produces a deep resonant boom, followed by a harsh, barking exhalation, which can be heard from a wide area.

Snatching birds from the air

Gibbons eat mostly fruit, such as figs, grapes and mangoes. They also eat leaves, posits, eggs and occasionally birds, which they have been seen catching in mid-air as they leap from one branch to another. In the tropical forests a group of gibbons can usually find all the food it requires within its territory as the trees fruit all the year round. Occasionally, however, the trees along the boundary are disputed with the neighbours.

Breeding all the year round

Gibbons breed all the year round. A single baby is born after a 7-month gestation. At first it is helpless and is carried, clasped to the mother's breast. A few weeks later it begins to take an interest in its surroundings and is carried clinging around its mother's waist like a belt. When she is swinging through the trees she raises her legs to give the baby extra support and protection. After weaning, the baby joins in the social life of its family. Mature at 6 years old, gibbons live to about 25 years.



Smallest but the most successful ape, a gibbon hangs by a hand. The hands have long fingers and the thumbs appear long because they are deeply cleft from the palms of the hand.

Photo Researchers

Not so dim

Gibbons are often said to be the least intelligent of apes, but recent tests have shown that they may be as intelligent as chimpanzees. The reason for the gibbons' supposed lack of intelligence was that they were not so adept at problem-solving tests as the other apes. The tests are absurdly simple for a man. Food such as a banana is placed out of reach beyond the bars of the apes' cage. A piece of string is tied to the banana and led to the bars. The ape has no trouble pulling the string to get its banana but the situation is made more difficult by having two pieces of string. One, for instance, may run straight from banana to cage, but pulling it does not draw the banana nearer, while the other runs first away from the cage then back, and is the right one to pull to get the banana. The ape can solve the problem by trial-and-error, pulling strings at random until it gets the right one, or, by insight, that is by working out the problem in its head.

Gibbons were apparently unable to solve these problems, but it seems that they were unfairly set. The strings ran along the ground and gibbons had difficulty in grasping them. If, however, the strings are raised,

the gibbons, being adapted for hanging on to branches or vines, could take hold of them. This is a point of great importance in designing tests of an animal's intelligence. It has to be able to carry out the necessary movements. For example, it would be no good expecting a dog to pull a suspended string with its paws. Using the improved tests it was found that gibbons could solve the problems as well as other apes. First they would pull the wrong string, and give up and climb round the cage. Then, suddenly, they would return and without hesitation pull the right string. Apparently they had been thinking about the problem and worked it out.

class	Mammalia
order	Primates
family	Pongidae
genera & species	<i>Hylobates concolor</i> <i>concolor</i> gibbon <i>H. hooleck</i> hooleck gibbon <i>H. lar lar</i> gibbon <i>H. pileatus</i> black-capped gibbon <i>Symphalangus syndactylus</i> siamang <i>S. klossii</i> dwarf siamang

Giganturid

This name, which looks very queer to the non-zoologist, is deliberately used to introduce a very odd deep-sea fish, one that breaks all the rules. There are several species in one genus *Gigantura*, belonging to one family placed in a suborder on its own. The several species, which differ from each other in small details only, have been brought up from depths between 1 500–6 000 ft in both Atlantic and Indian Oceans. The name suggests giant fishes but they are usually between 2–5, rarely as much as 8, in. long. In fact, when we break up the name we find it is made up of a Latin word *giganteus* and a Greek word *uros* meaning tail. It refers not to the size of the fish but to

made. The shape, number and disposition of the fins of a giganturid suggests that they do not swim rapidly. On the other hand, it is a mystery why it should be slow or why it has no scales. And the long lower tail fin is hardly more easy to explain. We are on firmer ground about the way it feeds because the strong jaws and sharp teeth mark it as predatory. Moreover, because its teeth are depressible we could suppose it swallows large prey, the teeth being lowered to allow more room for large prey to be taken into the mouth. This line of argument is supported by the elastic stomach of a giganturid and by those brought to the surface that have recently swallowed a fish as large or larger than themselves. One giganturid, appropriately named *Gigantura vorax*, itself 3 in. long, had swallowed another fish $5\frac{1}{2}$ in. long. Moreover, this fish was doubled up, suggesting that the giganturid had seized it by the middle

they can. A further theory is that the eyes, which have an accessory retina of short rods as well as the main retina, are specially adapted for picking up the luminescence from the light organs of their prey.

Problems to be settled

The eyes of fishes are essentially like ours but there are differences, one of them being that the lens, instead of being oval, is spherical and bulges well through the pupil. Consequently, with the eyes set on the sides of the head a fish has a wide all-round vision, necessary because it has no neck and cannot turn its head to look for food or keep watch for enemies. It has, so to speak, the next best thing to having eyes in the back of its head! Most fishes, also, are long-sighted despite a popular belief that they are short-sighted. In addition, many fishes can swivel their eyes forward

Gigantura – tubular-eyed fish with a body 2–5 in. long is found in the deep waters of both the Atlantic and Indian Oceans



the extraordinarily long lower lobe of the tail fin. And if the name is misleading this is appropriate because almost everything else about the fish is misleading.

Catalogue of oddities

Giganturids have slender rounded bodies. They lack pelvic fins as well as a number of other anatomical parts, normally considered essential to the life of a fish, including several bones of the head. They also lack light-organs which are such a feature of deep-sea fishes. They have needle-sharp teeth that can be raised and lowered. The pectoral fins are unusually large for the size of the body. Their bodies are scaleless and whereas other fishes living at these depths are black or dark brown, giganturids are a bright, metallic silver colour, like fishes that live near the surface. Above all, these fishes have tubular eyes directed forwards, as if they were wearing binoculars. There are a few other fishes with tubular eyes but usually these are directed upwards.

Huge meals at long intervals

As with all deep-sea animals virtually nothing is known of the way they live except what can be deduced from the way they eat

and had swallowed it bent into a V.

Then comes the question: how does a giganturid breathe while swallowing such large prey, which must take an appreciable time? One suggestion is that while doing this, and so prevented from taking in water through the mouth to pass across the gills, the large pectoral fins are used to fan water into the gill-chamber for breathing.

Why do they wear binoculars?

So far as the food and feeding habits are concerned, all that has so far been deduced fits into the general pattern of what is already known for the cannivorous deep-sea fishes. That is, they are living in depths where food is not abundant so they must take whatever food presents itself even to swallowing prey larger than themselves. So they make up for the infrequency of their meals by taking huge meals when opportunity offers. What is now needed is to guess why the tubular eyes are required. One view is that they act like the telephoto lens of a camera so the giganturid can see prey a long way off, even in the murky gloom at great depths. Another is that they need this improved vision because they are poor swimmers and, presumably, must stalk prey that cannot see as far as

to give better vision forwards. This can be seen when we look at a fish in an aquarium as it faces us head-on as in the angelfish, picture on page 54. It can also be seen on the television screen when underwater close-up pictures of fishes are being shown. These considerations show how specialised are the eyes of giganturids, which can only look directly forwards. Perhaps one day we may know how they are compensated for this loss of all-round vision, with eyes in the front of the head only. They may have other senses for detecting the approach of food or enemies from behind. Perhaps the scaleless skin means it is more sensitive to vibrations in the water. And then, there is the long lower tail fin—the giant tail—to be accounted for, giving only one of the many problems to which answers will be eagerly awaited.

class	Pisces
order	Cetomimiformes
family	Giganturidae
genus	<i>Gigantura vorax</i>
& species	others



COURTESY OF BOB KRIEGER

If *hacks* could kill, massive-headed, belly-dragging, obese and ugly, the Gila monster is among the more repulsive of reptiles and one of the only two poisonous lizards. Surprisingly, many people have kept it as a pet, enough, in fact, to make it rare. It is now protected by law.

Gila monster

Only two out of about 3,000 kinds of lizards are poisonous: the Gila monster (pronounced 'heela') and the bearded lizard. They look alike and live in deserts of the southwestern United States and adjacent parts of Mexico respectively. The first is named for the Gila basin in Arizona where it is plentiful, the second after the bearded nature of its scales.

The Gila monster is up to 23 in. long and weighs up to 3½ lb. It is mainly pink and yellow with black shading. The bearded lizard, up to 32 in. long, is mainly black with pink and yellow patches. The Gila monster has 4–5 dark bands on the tail. The bearded lizard has 6–7 yellow bands. Both have a stout body, large blunt head, powerful lower jaw, small eyes, an unusually thick tail, short legs with 5 toes on each and remarkably strong claws.

Alternate gluttony and fasting

These lizards move about very slowly, although when captured they can move swiftly and struggle actively, hissing all the while. They spend long periods of time in their burrows in the sand, coming out at the tiny season and even then mainly at night. Being slow movers they must eat things that

cannot run away. These are mainly eggs of birds and other reptiles, baby birds and baby mice and rats. They track them down partly by smell but more especially by taste, using the tongue to pick up scent particles on the sand from birds' nests or rodents' burrows. These are conveyed by the tongue to Jacobson's organ, a sort of taste-smell organ in the roof of the mouth. They eat insects and earthworms in captivity and from the behaviour of these captive animals it seems unlikely that venom is used to kill prey. Eggs are either seized, the head raised and the shell crushed so the contents flow into the mouth, or bitten in two and the tongue used to lap up the contents as the shell lies on the ground. The Gila monster drinks liquid food by lapping it up and holding its head back to let the liquid run down its tongue.

While active these lizards eat all they can find and store the surplus as fat in the body and especially in the tail. When well-fed their skeleton represents a small part of the total weight of the body and the lizards can then survive long periods of fasting. The fat tail will then shrink to ½ its former girth and the rest of the body will be little more than skin and bone. The lizard will quickly recover once it can find food. One that had survived three years drought, during which it took no food, was taken into captivity and in 6 months its tail had doubled in size and the body was as plump as usual.

Inefficient venom apparatus

The venom glands are in the lower jaw although teeth in both jaws are grooved. Each gland has several ducts that open into a groove between the lower lip and the gum, and the poison finds its way from this to the grooves in the teeth. Neither of the lizards can strike as a snake does but must hold with the teeth and hang on with a vice-like grip sometimes chewing to help conduct the venom. If bitten by a monster, the main problem is to free the tight-gripping jaws.

Nests in the sand

Mating takes place in July and eggs are laid a few weeks later. These are laid in a hole dug by the female with her front feet and covered with sand. There may be 3–15 in a clutch, each egg about 1½ by 2½ in. and oval, with a tough leathery shell. They hatch in about a month, the young lizards being 3½–4½ in. long, and more vivid in colour than the parents.

Legally protected monster

Little is known of the natural enemies of the two poisonous lizards but by 1952 the Gila monster was becoming so rare it had to be protected by law to save it from extinction. It was being caught and sold in large numbers as a pet. Those who caught them were paid 25–50 cents an inch, and the lizards were then sold at 1–2 dollars an inch.



Lizard with a bad name

In striking contrast with the popularity of the Gila monster as a pet are many erroneous beliefs that have gathered around it in the past. One is that it cannot eliminate body wastes, which is why it is so poisonous. For the same reason its breath is evil-smelling. Another is that it can spit venom, whereas at most, when hissing, it may spray a little venom. The lizard has been credited also with leaping on its victims, largely the result perhaps of the way it will lash out from side to side when held in the hand. Its tongue has been said to be poisonous, the lizard itself impossible to kill and possessed of magical powers. Lastly, it has been said to be a cross between a lizard and a crocodile.

More than 400 years ago, a Spaniard, Francisco Hernandez, wrote that the bite of the lizard though harmful was not fatal, that it threatened no harm except when provoked and that its appearance was more to be dreaded than its bite. Although his writings had been overlooked the first scientists to study it seem to have taken much the same view when they named it *Heloderma suspectum*, because they were not sure whether it was poisonous, only suspected of being so. They were more certain about the beaded lizard which they named *H. horridum*. Now we know that the poison is a neurotoxin which causes swelling, loss of consciousness, vomiting, palpitations, laboured breathing,

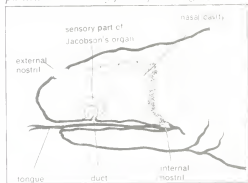
△ *Lizard couisseur*: using tongue and 'nose', a Gila monster tests its surroundings.

dizziness, a swollen tongue and swollen glands. Not all these symptoms appear in one person, however. The swelling and the initial pain are due to the way the poison is injected. The lizard must hold on and chew with a sideways action of the teeth.

In 1956 Charles M Bogert and Rafael Martin del Campo published in America the results of their thoroughgoing investigation into the injuries suffered by human beings from the bite of the Gila monster. They found only 34 known cases of which 8 were said to have been fatal. Most of those who had died were either in poor health at the time or drunk. In several instances there were signs of repeated biting, as in the case of the man who carried the lizard inside his shirt, next to his skin. This may explain the drunks who fell victim. They teased the lizards in zoos and probably did not realise they were being repeatedly bitten.

class	Reptilia
order	Squamata
suborder	Sauria
family	Helodermatidae
genus	<i>Heloderma horridum</i> beaded lizard
& species	<i>H. suspectum</i> Gila monster

▽ Section through Gila monster's head, showing Jacobson's organ in the roof of the mouth. This is specialised for taste and smell; scents are carried to it through the external nostrils (visible in both the pictures above), and particles are taken by flicks of the tongue.



The lofty ones

Dappled necks of the African wild, a group of giraffes are both extraordinary and, against the backdrop of a pale sunset,



Giraffe

Tallest animal in the world, the giraffe is remarkable for its long legs and long neck. An old bull may be 18 ft to the top of his head. Females are smaller. The head tapers to mobile hairy lips, the tongue is extensile and the eyes are large. There are 2–5 horns, bony knobs covered with skin, including one pair on the forehead, a boss in front, and, in some races, a small pair farther back. The shoulders are high and the back slopes down to a long tufted tail. The coat is boldly spotted and irregularly blotched chestnut, dark brown or liver-coloured on a pale buff ground, giving the effect of a network of light-coloured lines. A number of species and races have been recognized in the past, differing mainly in details of colour and number of horns, but the current view is that all belong to one species. The number of races recognised, however, varies between 8 and 13 species depending on the authority.

The present-day range of the giraffe is the dry savannah and semi-desert of Africa south of the Sahara although it was formerly more widespread. Its range today is from Sudan and Somalia south to South Africa and westwards to northern Nigeria. In many parts of its former range it has been wiped out for its hide.

A leisurely anarchy

Giraffes live in herds with a fairly casual social structure. It seems that males live in groups in forested zones, the old males often solitary, and the females and young live apart from them in more open country. Males visit these herds mainly for mating.

Giraffes do not move about much, and tend to walk at a leisurely pace unless disturbed. When walking slowly the legs move in much the same way as those of a horse. That is, the right hindleg touches the ground just after the right foreleg leaves it, and a little later the left legs make the same movement. The body is therefore supported on three legs most of the time while walking. As the pace quickens to a gallop the giraffe's leg movements change to the legs on each side moving forward together, the two right hoofs hitting the ground together followed by the two left legs moving together.

The long neck not only allows a giraffe to browse high foliage, the eyes set on top of the high head form a sort of watch-tower to look out for enemies. In addition, the long neck and heavy head assist movement by acting as a counterpoise. When resting crouched, with legs folded under the body the neck may be held erect or, if sleeping, the giraffe lays its neck along its back. To rise, the forelegs are half-unfolded, the neck being swung back to take the weight off the forequarters. Then it is swung forwards to take the weight off the hindlegs, for them to be unfolded. By repeated movements of this kind the animal finally gets to its feet.

Adult giraffes apparently sleep little: not at all according to some authors, one-half hour in 24 according to others.

Necking parties

The habit of 'necking' has been something of a puzzle. Two giraffes stand side-by-side and belabour each other with their heads, swinging their long necks slowly and forcibly. Only rarely does any injury result, and the necking seems to be a ritualized fighting, to establish dominance, and confined exclusively, or nearly so, to the male herds.

Not so dumb

One long-standing puzzle concerns the voice. For a long time everyone accepted the idea that giraffes are mute—yet they have an unusually large voice-box. During the last 25 years it has been found that a young giraffe will bleat like the call of domestic cattle, that the adult female makes a sound like 'wa-ray' and that adult bulls, and sometimes cows, will make a husky grunt or cough. Nevertheless, there are many zoologists who have never heard a giraffe utter a call and there is still the puzzle why there should be such a large voice-box when so little use is made of it. Some zoologists have suggested the giraffe may use ultrasonics.

Controlled blood pressure

In feeding, leaves are grasped with the long tongue and mobile lips. Trees and bushes tend to become hourglass-shaped from giraffes browsing all round at a particular level. Acacia is the main source of food but many others are browsed, giraffes showing definite preferences for some species of trees or bushes over others.

Giraffes drink regularly when water is available but can go long periods without drinking. They straddle the front legs widely to bring the head down to water, or else straddle them slightly and then bend them at the knees. Another long-standing puzzle concerns the blood pressure in the head, some zoologists maintaining a giraffe must lower and raise its head slowly to prevent a rush of blood to the head. In fact, the blood vessels have valves, reservoirs of blood in the head and alternative routes for the blood, and so there is no upset from changes in the level of the head, no matter how quickly the giraffe moves.

Casual mothers

Mating and calving appear to take place all the year, with peak periods which may vary from one region to another. The gestation period is 420–468 days, the single calf being able to walk within an hour of birth, when it is 6 ft to the top of the head and weighs 117 lb. Reports vary about the suckling which is said to continue for 9 months, but in one study the calves were browsing at the age of one week and were not seen suckling after that. The bond between mother and infant is, in any case, a loose one. Giraffe milk has a high fat content and the young grow fast. Captive giraffes often live for over 20 years.

Defensive hoofs

Giraffes have few enemies. A lion may take a young calf or several lions may combine to kill an adult. Even these events are rare because the long legs and heavy hoofs can be used to deadly effect, striking down an attacker.

Symbol of friendliness

Rock engravings of giraffes have been found over the whole of Africa and some of the most imposing are at Fezzan in the middle of what is now the Sahara desert. The animal must have lingered on in North Africa until 500 B.C. Some of the engravings are life size, or even larger, and many depict the trap used to capture giraffes, while others show typical features of its behaviour, including the necking. The engravings also show ostriches, dibatag, and gerenuk. Giraffes were also figured on the slate palettes, used for grinding malachite and haematite for eye shadows, in Ancient Egypt, similar to that believed to portray the dibatag. The last giraffe depicted in Egyptian antiquities is on the tomb of Rameses the Great, 1225 B.C.

There are references to the animal in Greek and Roman writings and a few pictures survive from the Roman era, but from then until the 7th or 8th century AD the principal records are in Arabic literature. The description given by Zakariya al-Qaswini in his 13th-century *Marvels of Creation* reflects the accepted view, that 'the giraffe is produced by the camel mare, the male hyaena and the wild cow'. The giraffe was taken to India by the Arabs, and from there to China, the first arriving in 1414 in the Imperial Zoological Garden in Peking. To the Chinese it symbolized gentleness and peace and the Arabs adopted this symbolism, so a gift of a giraffe became a sign of peace and friendliness between rulers.

In medieval Europe, and until the end of the 18th century, knowledge of the giraffe was based on descriptions in Greek and Roman writings and on hearsay accounts. It was at best a legendary beast.

class	Mammalia
order	Artiodactyla
family	Giraffidae
genus	
& species	<i>Giraffa camelopardalis</i>

Wiped out for its hide in many parts of its range, the present day distribution of the giraffe is much reduced. A number of races are recognised within the single species.

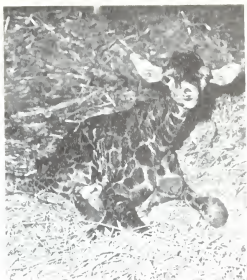


Below: The happy couple. A pair of giraffes, one female in company with her young, are seen in London Zoo and in the wild. The giraffe in the wild is in its first stage of life, the only one with white patches on its body. The giraffe in the wild is in its first stage of life, the only one with white patches on its body. The giraffe in the wild is in its first stage of life, the only one with white patches on its body.



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Giraffes at home

Far right: Using long tongue and mobile lips, a giraffe feeds on ground-growing plants.

Right: Top gear. A herd of females and young gallop away from a disturbance.

Below: Feathered grooms. A pair of oxpeckers dwell on the parasites from the neck of a common but disgruntled giraffe.

Below right: The long way down. Giraffe at a waterhole during a drought in Nairobi Park.

One might expect the blood to run into a giraffe's head in this awkward position, but a

system of reservoirs and valves, inside the arteries, prevents this. A giraffe will drink

regularly if there is water nearby, but in times of drought it can abstain for some time.

Below far right: Tough tongued eater. Ignoring thorns in its mouth, a giraffe makes the best of a sharp meal, while avoiding prickly scratches with its flexible neck.

Osipov



N. Myers-Bowman

Phillips Scott Photo Res





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See-through skin and shining colours make glassfishes popular in aquaria. Left: Siamese glassfish *Chanda wolffii*. Above: *Chanda lala*.

Glassfish

This is an obvious name for fishes that are transparent, with the skeleton and some internal organs clearly visible; yet although transparent they do not lack colour. A number of fishes are transparent or translucent but the name "glassfish" is reserved for certain small fishes that are favourite aquarium fishes. In the same family, however, are large game or commercial fishes, including the snooks and the Nile perch. As we shall see, the glassfish and the Nile perch, although so different to look at, have one thing in common; they have both, at different times, ended in the ground.

The body is deep and strongly compressed from side-to-side. The dorsal fin is in two parts, that in front being supported by hard rays, the rear portion having one hard ray and up to 18 soft rays. The tailfin is either rounded or deeply forked.

The 8 or more species are found from East Africa through southern Asia to eastern Australia, the majority being in southeast Asia.

The 8 species of snooks live in the seas of tropical west and east Atlantic and the eastern Pacific. They readily enter rivers and may be $\frac{1}{2}$ ft long with a weight of 51 lb. The Nile perch, up to 7 ft long and more than 250 lb weight, is only one of several related African game species. It looks much more substantial than the glassfish and a special account of it will be given later.

Living gems for fertilizers

The Indian glassfish looks like a piece of crystal floating and reflecting colours in water. It is up to 3 in. long, greenish to yellowish but shining gold or iridescent bluish-green in reflected light. The flanks are marked with bars made up of tiny black dots, with a delicate violet stripe running from the gill-cover to the root of the tail. The fins are yellowish to rusty-red, the dorsal and anal fins with black rays and bordered with pale blue. Rays of paired fins are red or bluish.

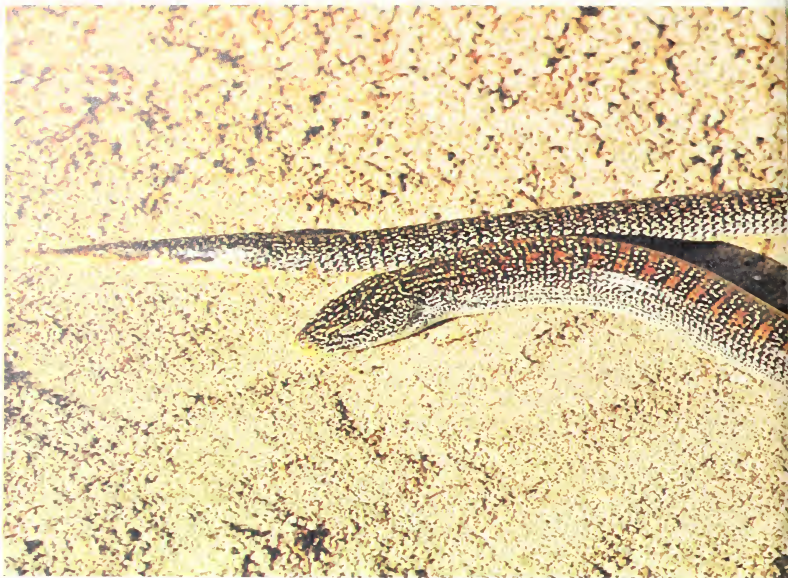
It is the best known of the small glassfishes, and lives in fresh and brackish waters of India, Burma and Thailand. Its uneventful life is spent among water plants feeding on small aquatic animals such as insect larvae, crustaceans and worms. Its breeding habits are almost equally uneventful. In aquaria, according to Günther Sterba, spawning is triggered by morning sunshine raising the temperature, and a brief separation of the sexes, by putting them in separate tanks, for a short time then reuniting them. The pair take up position side-by-side, quivering all the time. As the female lays the pair turn over to an upside-down position. The female lays her eggs among water plants to which they stick. She lays 4-6 at a time, repeating this until 200 or more have been laid. After this the parents take no further interest. The eggs hatch in 3-24 hours, depending on temperature, the baby fishes hanging from the water plants for 3-4 days after which they swim freely. Their food is small crustaceans, such as water fleas. The young glassfishes do not go in search of food but snap up any that drifts past them. It can be presumed that if food is scarce around the area at such times many

young fishes will die of starvation. Nevertheless, large numbers survive for, as William T Innes remarks in his *Exotic Aquarium Fishes*, this little gem treasured by aquarists is caught in large numbers in India and Burma for use as a fertilizer.

Family likenesses

Two people when related even distantly often share what we call a family likeness. In height, girth, colour of hair and in almost every way the two may be wholly unlike yet there is something that marks them as belonging to a family. It may be something very small, for example, a peculiarity in the way they walk, the shape of the lower lip, and so on. It is the same in classifying animals, and the family we are considering here is a fine example. Included in it are glassfishes, small, transparent, delicate; as well as snooks that are large, sturdy and not transparent and the 7ft robust giant, the Nile perch. From a casual glance they look most unlike yet each has a similar outline, and each has at least one small feature we call a family likeness. In each the lateral line, the line of sense-organs running along the flanks of fishes, goes right to the end of the tailfin, which is most unusual.

class	Pisces
order	Perciformes
family	Centropomidae
genera & species	<i>Chanda ranga</i> Indian glassfish <i>Centropomus unidecimalis</i> snook <i>others</i>



Glass snake

Glass snakes are in fact, legless lizards that bear little snakes. The *Schelopaps* in *Pallas' glass snake* of southeast Europe and *Asia* is 1.5 ft long and about 2 in. across the body. It was first discovered by the naturalist Pallas on some old ships belonging to the Volga. Since then it has been found in far west as Hungary and it is widespread throughout the Balkan peninsula. Another living in southwest India and Burma is 15 in. long and the glass snake of southern China is 2 ft long. There is another glass snake in America and 3 others in North America, up to 3 ft long, ranging from Lake Michigan southwards through the eastern and southern states and into Mexico. One American species *O. ventralis* is brown, olive or black with green spots or stripes and greenish-white underneath.

Two-thirds of their length is made up of tail, whereas in snakes the tail makes up only a small fraction of the total length. Pallas' glass snake is brown, yellow or chestnut-brown, often with two pale spots, and very old individuals are coppery-ard. The glass snake of southern China has an

olive back and bright blue flanks. All glass snakes have a deep furrow running along each side of the body from the neck to the vent. There is no trace of the forelimbs and, in the European and North African species, there is a barely noticeable stump of a hindlimb at the rear end of the furrow.

Snake-like but not snakes

Glass snakes live in fields or copses, among tufts of stones or in bare rocky places. They avoid dense woods. They are not as agile as snakes but they can clamber over rocks easily. They do not climb trees, and they avoid water. Their habit is to hide under fallen leaves or burrows just beneath the surface where the soil is sandy and light. When they do come out they move over the ground like snakes but with a less graceful action. When chased they move with a rapid twisting of the body, stopping every 2-3 rd for a rest.

Glass snakes feed by day on insects, especially grasshoppers. They sometimes take mice, lizards, fledgling birds and the eggs of snakes and birds. Live prey is twisted rapidly round and round or beaten against the ground until stunned and then chewed with powerful jaws and swallowed whole. Glass snakes are said to eat snakes, including adders. When eating an egg they crack the shell with their jaws and ladle out the con-

tents with their flat forked tongues. The American glass snake, also called glass lizard or joint snake, seems to spend more time burrowing than the European form. It has a similar diet but is said to eat earthworms as well as other underground animals.

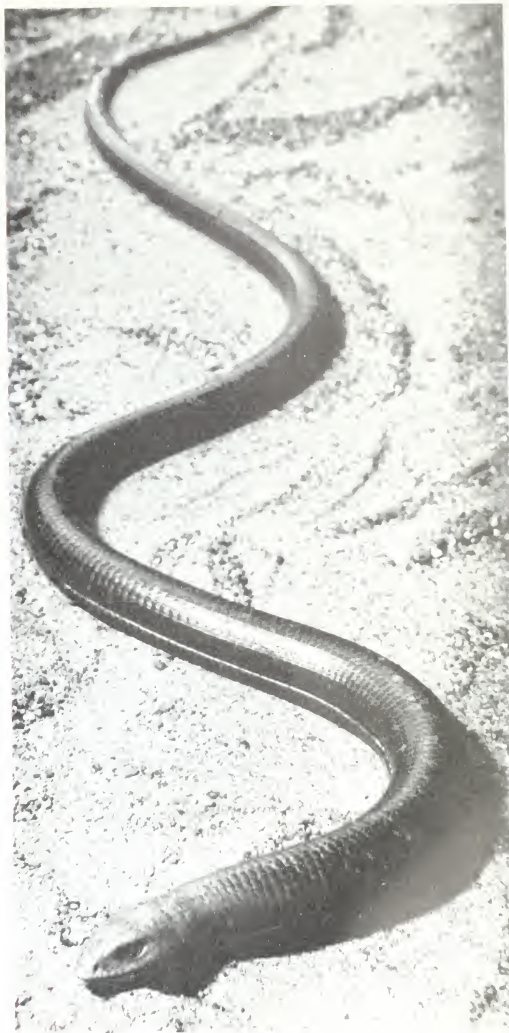
The females lay their inch-long eggs under moss or dead leaves, 8-10 at a time. They take about a month to hatch, the female guarding them during that time in a half-hearted way. The newly-hatched glass snake is 5 in. long, ashen-grey with dark spots and bands along the back and dark vertical stripes on the sides of the head. They take several years to reach maturity and the glass snakes are said to live up to 60 years.

Two lines of defence

Little is known about the enemies of glass snakes. They would be likely to be taken by large birds of prey. They have, however, two lines of defence. Like other lizards they can shed their tails when attacked, and if held in the hand they twine round it in a most unpleasant manner, which would probably deter all but a large or a persistent predator.

Falling to bits

Glass snakes are named for their reputation of breaking into pieces when struck with a stick. The legend continues that the pieces



later reassemble and that the lizard is none the worse for its adventure. As in other lizards the tail is shed in moments of alarm, but in glass snakes it also breaks into several pieces. Because the tail is so long, the body of a glass snake that has just cast its tail looks very small, little bigger than one of the portions of the shed tail, so it looks as if the whole animal is in pieces.

class	Reptilia
order	Squamata
suborder	Sauria
family	Anguidae
genus	<i>Ophisaurus apodus</i> European glass snake
& species	<i>O. ventralis</i> N. American glass snake others

△ Brittle-tailed reptile: the 'glass' half of this animal's name is perhaps justified by the way its tail will fall off and break into several pieces in moments of alarm. 'Snake', however, does not apply; it is a legless lizard.
 ▷ Twisting sprinter—a European glass snake. Glass snakes do not move with the wriggling expertise of true snakes, especially when frightened; they use a twisting movement and have to stop for a rest every 2–3 yd.

Gliding frog

There are a few species of frogs which are also referred to as the so-called flying frogs. The reason they are called flying frogs is because they do not fly, they only glide. It is high time we began to do away with the term flying frogs and followed the lead given, for example, by David B. Crookston, of the United States National Museum, and called these gliding frogs, which is what the name is.

The gliding frogs are members of a group of tree frogs, *Rhacophoridae*, which will be dealt with later. The most common are the Malayan and Wallace's gliding frogs which are four long on the hind and body, showing green above, yellow on flanks and grey underneath. They range from Malaya to Borneo. As with other tree frogs of this family the ends of the toes on all four feet have sucker discs at the tip for clinging to trees. Gliding frogs differ in having the toes of all four feet longer than usual and fully webbed.

Jumping and gliding

Gliding frogs spend the day in trees and tall bushes holding on by the discs on their toes. In strong sunlight they are a greenish-blue, turning to green in the evening and finally to black, the change taking place more rapidly in the males than the females. They become active at night, leaping from branch to branch and taking gliding leaps from tree to tree. The leaps may be up to 6 ft but the glide may cover 10-50 ft to the base of the next tree. In a glide the toes are fully extended and held rigid and the underside of the body is drawn up, giving a concave surface that increases the lift. The direction and length of a glide can be controlled to a great extent.

Foam nests

Gliding frogs feed mainly on grasshoppers but take other insects as well, and when breeding they do not take to water but make foam nests among large leaves. While nesting the male clings on the female's back, as is usual in frogs. As the eggs are laid quantities of albumen are given out with them and both female and male beat this into a frothy mass with a paddling action of the hindlegs. The outside of the mass hardens while the inside of it becomes more and more fluid. The eggs float in this fluid and washes either the eggs, or the tadpoles, out of the nest, to fall into pools below. If no rain falls the outer crust eventually hardens to release eggs or tadpoles.

Frogs' flying school

The first Europeans to learn about these frogs heard the story from Chinese labourers in southeast Asia who spoke of the frogs flying down from the trees. The story that there were frogs that flew was accepted at first. Then came disbelief and this was reinforced by a curious incident. Alfred Russel Wallace, the distinguished naturalist, who

worked so much in the southeast Asian region, calculated that the area of the spread feet with their webs was sufficient to enable the frogs to glide. He made an error in his calculations and when this was detected the story of flying frogs became further discredited. Few zoologists had ever seen the gliding frog alive so it was difficult to check Wallace's statement or those of the Chinese in Malaya. In 1926, however, HB Cott carried out experiments with the Brazilian tree frog *Hyla venulosa* which showed that gliding frogs with less webbing than gliding frogs could fall from considerable heights and land safely on their feet. He dropped the frogs from a tower 140 ft high and the frogs landed on the ground 90 ft out from the base of the tower. They reached the ground at such a slow speed that they were quite unharmed. Almost any small tree-living animal would

do the same and the reason is that they spread their legs and keep their body the right way up, as a cat does when it falls from a height, and this acts as a brake. By contrast, the ordinary common frog, although the webs on its feet are larger than those of a tree frog, simply tumbles head over heels when it falls and plummets straight down. It only needs that little extra webbing on the feet, which gliding frogs have, to keep them gliding.

class	Amphibia
order	Salientia
family	Rhacophoridae
genus	<i>Rhacophorus nigropalmatus</i>
& species	Wallace's gliding frog <i>R. reinwardtii</i> Malayan gliding frog

▽ Ready to go: a Siamese gliding frog *Rhacophorus prominatus* takes aim for the leap which will start its long glide towards the base of the next tree—perhaps 50 ft away.



▽ Airborne amphibian. Bornean gliding frog on the way down, each webbed foot a tiny parachute. Even the body is held concave to add to the gliding surface and so increase lift.



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